MACHINERY.

May, 1906.

SECTIONS OF CAST IRON BEAMS.

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DURING the winter of 1901-02 interesting experiments were carried on at the laboratories of the Case School by senior students A. F. Kwis and R. H. West. The object of these experiments was to determine the relative strength and stiffness of cast-iron beams having cross-sections of the same area but of different shapes.

The results have never been published and seem to the writer of sufficient interest to the designer of machinery to warrant their presentation.

Since it was necessary to eliminate all variables except the ones to be compared, great pains were taken with the casting of the test bars. The patterns were all twenty inches long and had the same cross-section of 4.15 square inches. As may be seen from the tables the areas of the cast beams varied slightly. The castings of each set were all made from the same ladle of iron and were cast on end. A soft gray iron was used and a large flush basin distributed the molten metal to the mold, giving a uniform temperature and quality. Acknowledgments should be made to Mr. Thos D. West for his assistance in the preparation of the castings, which were remarkably uniform in texture and quality.

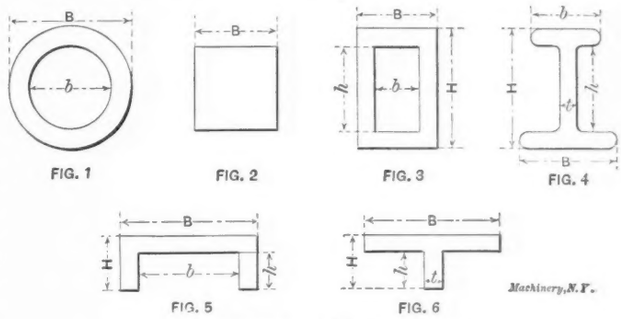
The specimens were all tested by loading transversely at the center, the supports being 18 inches apart.

Object.—The investigation had two distinct objects in view and two classes of test pieces were used. The first class comprised Nos. 1 to 11 and Nos. 22 to 32 and these specimens had sections such as are used in parts of machines.

The second class comprised Nos. 12 to 21 and 33 to 42, all having sections similar to those used in the rims of fly wheels. The object of this part of the investigation was to determine the influence of flanges on either the tension or compression sides of the sections.

Sections.—The sections of the beams in the first class were as follows: Solid circular, solid square, solid rectangular, hollow circular, hollow elliptical, hollow rectangular, I-sections with flanges of various proportions.

The illustrations show the general outlines and have letters on them referring to the dimensions given in the tables. The values of $\frac{I}{y}$, the section modulus, refers to the fiber in tension as do also the values for fiber stress.



Key to Dimensions of Sections Tested.

The dimensions given in the table are those of the pattern, while the areas are those of the specimens at the point of rupture. There are two specimens of each shape cast from the same pattern.

Experiments.—The section modulus $\frac{I}{y}$ was calculated from the dimensions of the casting at the breaking point. In testing each specimen the load was applied gradually and readings of the deflection were taken at regular intervals. When the "set" load was reached, the pressure was removed and a reading of the permanent set was taken. The load was again applied and observations made on the deflection up to near the time of rupture.

The load-deflection curves plotted from these observations are nearly all smooth and uniform in character, as may be seen by reference to Fig. 7 which shows the curves for No. 33.

The initial line curves gradually from the start showing an imperfect elasticity, while the set line is nearly straight and approximately parallel to the tangent of the curve at the ver-

TABLE 1.

No.	Section		Dimensions.					Section Modulus $=\frac{I}{y}$	Loads in Pounds.			Set in Inches.	Fiber Stress.	Modulus of Elasticity.
	Shape.	Area.	*B*	*b*	*H*	*h*	*t*		Breaking	When $\Delta = .03$	Set.			
1		4.40	2.3	.....	.....	.....	.....	1.304	7,500	2,500	5 000	.018	25,900	8,280,000
22		4.45	.....	.....	.....	.....	.....	1.324	7,250	2,600	5,000	.020	24,640	8,290,000
2		4.46	2.04	.....	.....	.....	.....	1.565	8,100	2,600	5,000	.016	23 300	8,650,000
23		4.41	.....	.....	.....	.....	.....	1.543	8,150	3,700	5,000	.005	23,600	9,850,000
3		4.50	1.04	.....	4.02	.....	.....	3.05	15,200	7,500	15,000	.0225	22,300	6,690,000
24		4.67	.....	.....	.....	.....	.....	3.19	17,100	8,000	15,000	.0195	24,120	6,530,000
4		4.43	3.4	2.5	.....	.....	.....	2.878	16,900	7,000	15,000	.020	26,450	6,660,000
25		4.37	.....	.....	.....	.....	.....	2.880	22,900	7,500	15,000	.018	35,800	7,440,000
5		4.20	3.81	3.04	.....	.....	.....	3.27	20,100	7,500	15,000	.0205	27,700	5,360,000
26		4.52	.....	.....	.....	.....	.....	3.494	22,700	7,000	15,000	.019	29,200	5,860,000
6	Machinery, N.Y.	4.36	3.	2.1	3.9	3.05	.....	3.175	25,400	6,500	20,000	.040	36,000	6,490,000
27		4.47	.....	.....	.....	.....	.....	3.27	25,100	.....	.....	.....	34,600	.....

tex. The so-called moduli of elasticity were calculated from the set lines using the formula

$$E = \frac{W l^3}{48 \triangle I}$$

In each test a reading of the load was taken at the instant when the deflection measured 0.03 inch, and these loads may be taken as a fair measure of the "stiffness" of the section.

Calculations.—The fiber stress was calculated from the breaking load and the section modulus, using the formula:

$$S = \frac{M y}{I} = \frac{W l y}{4 I}$$

section, from a minimum of 18,700 to a maximum of 36,000, show that the ordinary method of calculation would not be of much value in predicting the breaking load of such beams.

Comparison of Strength.—An investigation of the values in Table I. shows that the hollow circular and elliptic sections are much stronger than the solid sections, the increase in strength being greater than that of the section modulus. The average value of S for the last six numbers in Table I. is 31,600 as against 24,000 for the six solid sections, an apparent increase in the strength of the material itself of over 25 per cent. This is partly due to the thinner metal, the greater surface of hard "skin" and the freedom from shrinkage strains.

TABLE II.

No.	Section.		Dimensions.					Section Modulus $\frac{I}{y}$	Loads in Pounds.			Set in Inches.	Fiber Stress.	Modulus of Elasticity.
	Shape.	Area.	B	b	H	h	t		Breaking	When $\triangle = .03$	Set.			
7		4.36	3.09	2.53	4.0	3.25	.....	5.08	24,250	9,000	20,000	.020	21,500	3,290,000
28		4.40	.....	.....	.....	.....	.....	5.14	32,100	12,000	20,000	.011	28,180	5,530,000
8		4.25	3.22	3.22	4.0	3.1	.437	5.94	22,250	8,000	20,000	.018	17,700	3,750,000
29		4.88	.....	.....	.....	.....	.....	5.61	26,250	12,500	20,000	.010	21,100	5,340,000
9		4.87	4.22	2.5	4.0	3.25	.50	6.36	29,950	11,000	20,000	.015	21,220	5,760,000
30		4.81	.....	.....	.....	.....	.....	6.56	33,150	13,000	20,000	.012	22,800	5,480,000
10		4.70	4.22	2.22	4.0	3.15	.375	6.49	32,400	12,000	20,000	.013	22,500	5,380,000
31		4.53	.....	.....	.....	.....	.....	6.56	31,100	9,000	20,000	.015	21,380	4,040,000
11		4.63	3.70	2.70	4.0	3.15	.437	6.42	31,200	9,500	20,000	.019	21,900	4,630,000
32		5.12	.....	.....	.....	.....	.....	6.53	38,050	13,300	20,000	.007	26,220	5,050,000

TABLE III.

No.	Section.		Dimensions.					Section Modulus $\frac{I}{y}$	Loads in Pounds.			Set in inches.	Fiber Stress	Modulus of Elasticity.
	Shape.	Area.	B	b	H	h	t		Breaking	When $\triangle = .03$	Set.			
12		4.51	4	2.5	1.5	.75	.....	.81	5,400	2,100	4,000	.012	30,000	10 740,000
33		5.10	4	2.5	1.5	.75	.....	1.99	8,350	2,400	6,000	.024	18 900	8,570,000
13		4.48	4	.....	1.5	.75	1.5	.799	5 200	2,000	4,000	.013	29,300	8,430,000
34		4.67	4	.....	1.5	.75	1.5	1.68	7,000	2,000	6,000	.041	18,700	8 610 000
14		4.61	5	4.	1.62	1.	.....	.692	4,700	1,750	4,000	.017	30,580	10,170 000
35		4.80	5	4.	1.62	1.	.....	1.61	8 800	2,400	6,000	.024	24,600	11,060,000
15		4.48	5	.....	1.62	1.	1.	.731	4,200	2,000	4,000	.002	25,850	10,250,000
36		5.38	5	.....	1.62	1.	1.	1.74	9,450	2 500	5,000	.016	24,750	10,550,000
16		4.23	4	.....	1.87	1.12	1.	.802	4,300	2,500	4,000	.017	24,100	9,350,000
37		4.82	4	.....	1.87	1.12	1.	1.795	9,500	3,000	8,000	.040	23,800	10,740,000

As before noted the values of S and $\frac{I}{y}$ refer to the under or tension side of the beam. The modulus of rupture, as S is generally called, is supposed to represent the tensile stress on the outer fibers at the point of rupture and to measure in a way the transverse strength of the material. In the absence of a better measure we will use this, and take the circular and square sections as our standards. The average value of S for the four is 24,360 pounds per square inch.

This is a low value even for soft gray iron. The remarkable fluctuations in the value of S for specimens of different cross-

The absence of corners and the consequent uniformity of metal make this an ideal form of section.

The hollow rectangles and the I-sections given in Table II. have an average value of $S = 22,450$.

No. 8 is lower than the average and Nos. 28 and 32 considerably higher. These discrepancies are due to some accidental condition of the metal, since the mates of these pieces had about the average strength.

The relatively low values of S for this series are probably due to cooling strains in the metal. The table shows quite conclusively that the increase in strength in such section is not proportional to the increase in the section modulus.

Elasticity.—The values for the modulus of elasticity in Tables I. and II. seem almost ridiculous, if we are to regard this much abused "constant" as any criterion of the stiffness of a beam.

According to the results of tensile and transverse tests on cast iron E is a variable, being greatest for small loads and diminishing as we approach the breaking load.

Prof. Lanza gives values varying from nine to eighteen millions for a test on one bar. As has been explained the values of E were determined from the set lines which were approximately straight and not subject to the variation above mentioned. Examining the tables we find the values of E ranging all the way from 11,000,000 down to 3,290,000.

The larger values go with the smaller depths as in Nos. 17 and 38 and the smaller values are found in the sections having the largest section moduli as in Nos. 7 to 11.

This goes to show that the common formula for E does not apply well in the case of cast-iron sections and that the deflection of hollow and I-shaped sections is much greater than would be given by the formula. The columns giving the loads for a deflection of 0.03 inch illustrate this. For instance the values of I for Nos. 1 and 32 are 1.545 and 12.67 respectively, having a ratio of 8.2.

The loads required to produce the same deflection of 0.03 inch are 2,500 pounds and 13,300 pounds respectively, having a ratio of only 5.3.

Rim Sections.—The object of the experiments summarized in Tables III. and IV. was to determine the effect of flanges on the strength and stiffness of sections such as are used for the rims of fly wheels.

In order to illustrate this more clearly each alternate section was turned over so as to bring the flanges on the tension side, as may be seen by the shapes in the second columns of the tables.

The section modulus and the fiber stress was always calculated from the tension side.

In nearly every instance the calculated fiber stress is higher for the beam having the web in compression and the flanges in tension, or in other words there is not so much disadvantage in this latter arrangement as theory would indicate.

For instance, the section modulus for No. 34 is more than twice that of No. 13 of similar shape and area, but the breaking load is only one third greater. If we knew where the neutral axes of these sections really were during the process of bending we might perhaps explain this discrepancy.

Depth of Flanges.—Another object of these experiments on wheel rim sections was to determine the relative value of shallow and deep flanges. The average value of the breaking load for the ten sections with shallow flanges in Table III. is 6,690 pounds, and the average fiber stress about 25,000 pounds per square inch. The corresponding values for the ten sections with deeper flanges in Table IV. are 11,800 and 22,800. There is thus a slight falling off in the fiber stress for the deeper sections but not so much as was noticed in the two other tables.

The elasticity of these sections is more uniform than in those previously noticed, E varying from six to eleven millions. We notice, however, the same peculiarity as before, that the deeper sections are not so stiff in proportion to the values of I as those having shallow flanges.

The conclusions to be derived from these experiments can be stated in a few words:

TABLE IV.

No.	Section. Shape.	Section. Area.	Dimensions. B	b	H	h	t	Section Modulus $= \frac{I}{y}$	Loads in Pounds. Breaking	When $\Delta = .03$	Set.	Set in Inches.	Fiber Stress.	Modulus of Elasticity.
17		4.45	3.75	.....	1.94	1.56	1.78	1.404	7,650	3,500	5 000	.011	24,500	10,220,000
38		5.20	3.75	.....	1.94	1.56	1.78	2.14	10,900	4,250	6,000	.009	22,950	11,070,000
18		4.25	4.	.....	2.25	1.5	.75	.914	5,250	3,000	5,000	.018	25,900	9,060,000
39		4.60	4.	.....	2.25	1.5	.75	2.88	12,000	3 750	8,000	.022	18 700	10,750,000
19		4.41	5.	.....	2.25	1.62	.625	.835	4,400	7,250	.....	.....	23,700	.....
40		4.60	5.	.....	2.25	1.62	.625	2.30	12,250	3 750	10,000	.037	24 000	9 340,000
20		4 47	4.	.....	3.25	2.62	.625	1.774	7,900	5,500	6,000	.007	20,050	7.100.000
41		5.02	4.	.....	3.25	2.62	.625	4.36	22 600	8.000	20,000	.054	23,250	7.880,000
21		4.50	5.	.....	3.75	3.25	.5	1.784	10,200	7,250	10,000	.011	25,800	6,230,000
42		5.18	5.	.....	3.75	3.25	.5	5.95	25 000	9,250	20 000	.020	18,900	7,280,000

(1) The commonly accepted formulas for the strength and stiffness of beams do not apply well to cored and ribbed sections of cast iron.

(2) Neither the strength nor the stiffness of a section increases in proportion to the increase in the section modulus or the moment of inertia.

(3) The best way to determine these qualities for a cast iron beam is by experiment with the particular section desired and not by reasoning from any other section.

The experiments described in this article were made with unusual care on a remarkably clean and homogeneous iron and the regularity of the load curves shows accurate measurement.

That the calculated stresses and moduli show so wide a divergence must be attributed to the formulas rather than the work.

A set of preliminary experiments made on similar sections in 1901 gave results almost identical with those described, the values of S ranging from 22,000 to 35,000 and those of E from five to nine millions for a rather hard gray iron. The hollow circular sections made the best showing and the thin, deep I-sections the poorest.

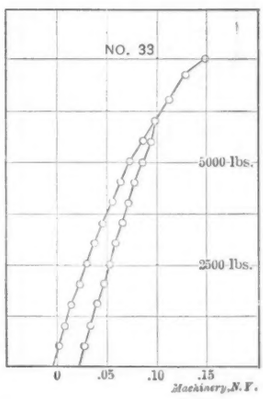


Fig. 7. Load Deflection Curves for Sample No. 33.

* * *

About the hardest material to remove from metallic surfaces is paint burned onto the front ends and cylinders of locomotives. The long-continued baking process to which numerous coats of black paint are subjected converts it into a substance almost as hard as the iron itself. Sand blast quickly removes the paint on ordinary iron surfaces, but on the front ends it takes from three to four times as long to clear the surfaces of the hardened scale.

VIEWS OF THE HOMESTEAD (PA.) CLUB HOUSE.

In view of the increasing number of club rooms and club houses that are now being provided by the managements of industrial plants to contribute to the comfort and welfare of their employees, the accompanying views of one of the three largest and finest club houses erected for this purpose in this country will be of interest. These views are of the house of the Homestead Club built by Andrew Carnegie for the steel workers at the Homestead plant. Similar structures were later erected at Braddock and Duquesne, the three being, as stated, the largest and finest buildings of the kind in the country. The board of directors of the Homestead Club is composed of the superintendent of the works, three other employees, and three townsmen.

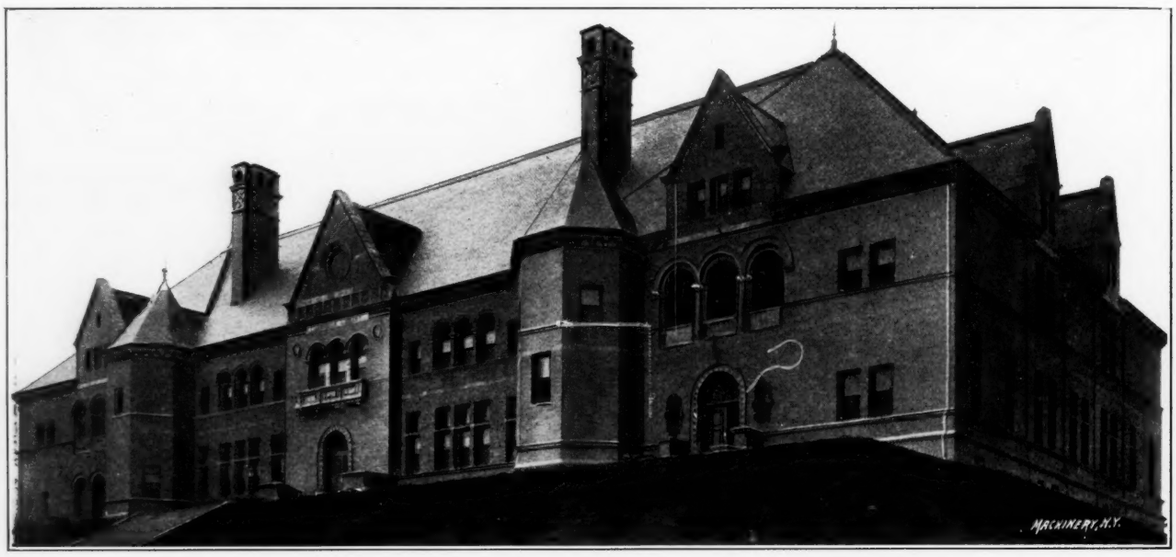


Fig. 1. Club House built by Andrew Carnegie for the Steel Workers of Homestead.

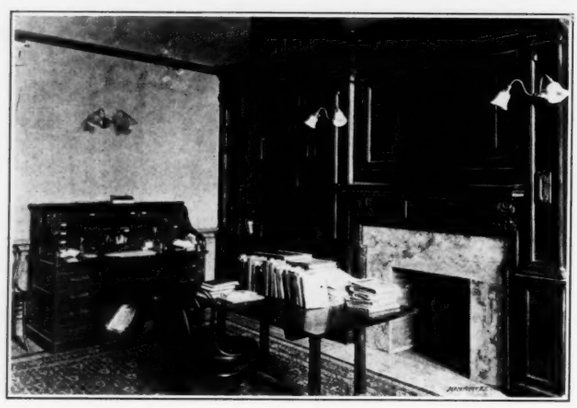


Fig. 2. A Corner of the Library.

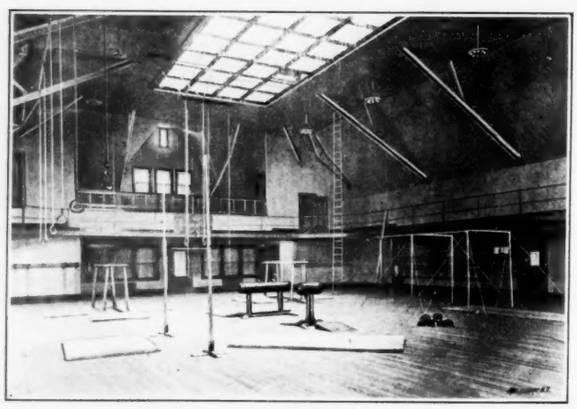


Fig. 3. The Gymnasium.

There is a free public library, open to all residents of Homestead who receive recommendations from the superintendent if they are unknown to the librarian. The day employees of the steel works patronize the library evenings, and when the men work night turns they utilize it afternoons. Connected with the library is a children's reading room. Rooms are provided for evening classes in arithmetic, mechanical drawing, chemistry, metallurgy, several languages, and stenography.

An auditorium, called Music Hall, contains a large pipe organ donated by Mr. Carnegie. Concerts, lecture courses, and theatricals are given there. The seating capacity is 1,142, and it is quite usual to be obliged to turn away as many who desire to attend the entertainments as those who participate. There is a regular entertainment course for which one dollar is charged for season tickets. There are other amusements which are free to club members, notably the organ recitals, held every two weeks.

Among other features of the building are a band room in which 35 members of the steel works band may practice; a lounging and smoking room furnished with beautiful rugs, leather couches and chairs, and containing, also, a cigar stand; a card room with six game tables; a billiard room with nine tables, where many of the employees have developed into skillful billiard players; a bowling alley; a room arranged for the wives and daughters of employees, called the Women's Parlor, where there are a pool table, a piano and card tables.

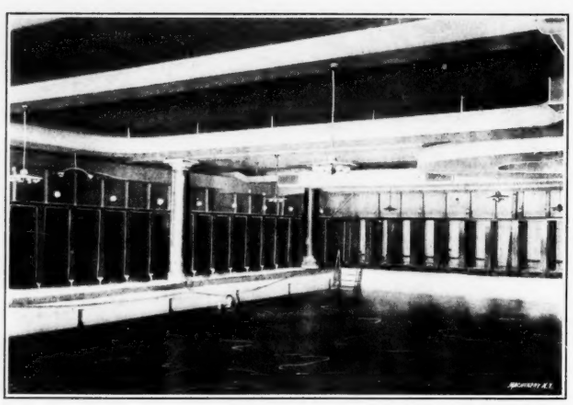


Fig. 4. Swimming Pool in the Basement.

Two of the most important departments of the building are the gymnasium and the swimming pool.

The gymnasium is equipped with substantial, scientific apparatus, and there is a competent physical director in charge. Separate classes are arranged for men, women, boys,

and girls. After each class the gymnasium floor is cleared for basket ball, indoor base ball, or other games.

The swimming pool in the basement is well patronized by the laboring men. Monday and Friday afternoons, from four to six o'clock, the women are allowed the use of the swimming pool, and there are special times arranged for the boys, so that they do not interfere with the enjoyment of the large crowd of men who are able to attend only after working hours. There are also in the basement eighteen tub baths and four shower baths, as well as toilet arrangements, for the men. The women have a dressing room with four baths.

While the library is for the free use of the citizens of Homestead, only club members may enjoy the other privileges of the building. The dues are:

	Three Months.	One Year.
Carnegie employees	$1.50	$4.00
Non-employees	2.00	6.00
Women	1.00	4.00
Boys and girls under 18.....	.50	2.00

* * *

Under the title "The Conditions of Fan-Blower Design" Walter B. Snow in *Cassier's Magazine* for January, states that "in the design of a wheel to meet given requirements, it is necessary to make its peripheral speed such as to create the desired pressure, and then so proportion its width as to provide for the required air volume. Evidently the velocity and corresponding pressure may be obtained either with a small wheel running at high speed, or a large wheel running at low speed. But if the diameter of the wheel be made too small, it may be impossible to adopt a width, within reasonable limits, which will permit of the passage of the necessary amount of air under the desired pressure. Under this condition it will be necessary to run the fan at higher speed in order to obtain the desired volume. But this results in raising the pressure above that desired, and in unnecessarily increasing the power required. On the other hand, if the wheel be made of excessive diameter, it will become almost impracticable on account of its narrowness. Between these two extremes a diameter must be intelligently adopted that will give the best proportions. In practice the width of a ventilatiing fan seldom exceeds one-half its diameter. In a fan for high pressures the proportion may run as low as one to twenty."

PATENTS IN THEIR RELATION TO THE GAS ENGINE AND THE AUTOMOBILE.—3.

S. M. HOWELL.

By an oversight of the author in the first article of this series the Robson patent of 1881 was shown as the first example of a two-cycle engine working a compressed charge. There was, however, an earlier construction; namely, the Dugald Clerk English patent of August 1, 1878. A United States patent on this invention was also taken out by Mr. Clerk on July 27, 1880, No. 230,470. This patent is therefore entitled to priority over that of Robson. Mr. Clerk's engine received an impulse at each revolution of the shaft, and he incidentally alludes to this feature in his specifications. The ignition was effected by means of a bundle or roll of sheet platinum placed in a pocket connecting with the cylinder by means of a timing valve. The platinum was maintained at an incandescent temperature partly by the heat of the explosions.

The well-known hot-tube system of ignition is a development of this incandescent platinum method, having been applied by Daimler and others. The device originated, however, at a much earlier date than that of the Clerk patent; having first appeared in a gas engine patent granted to Stewart Perry of October 7, 1846, No. 4,800.

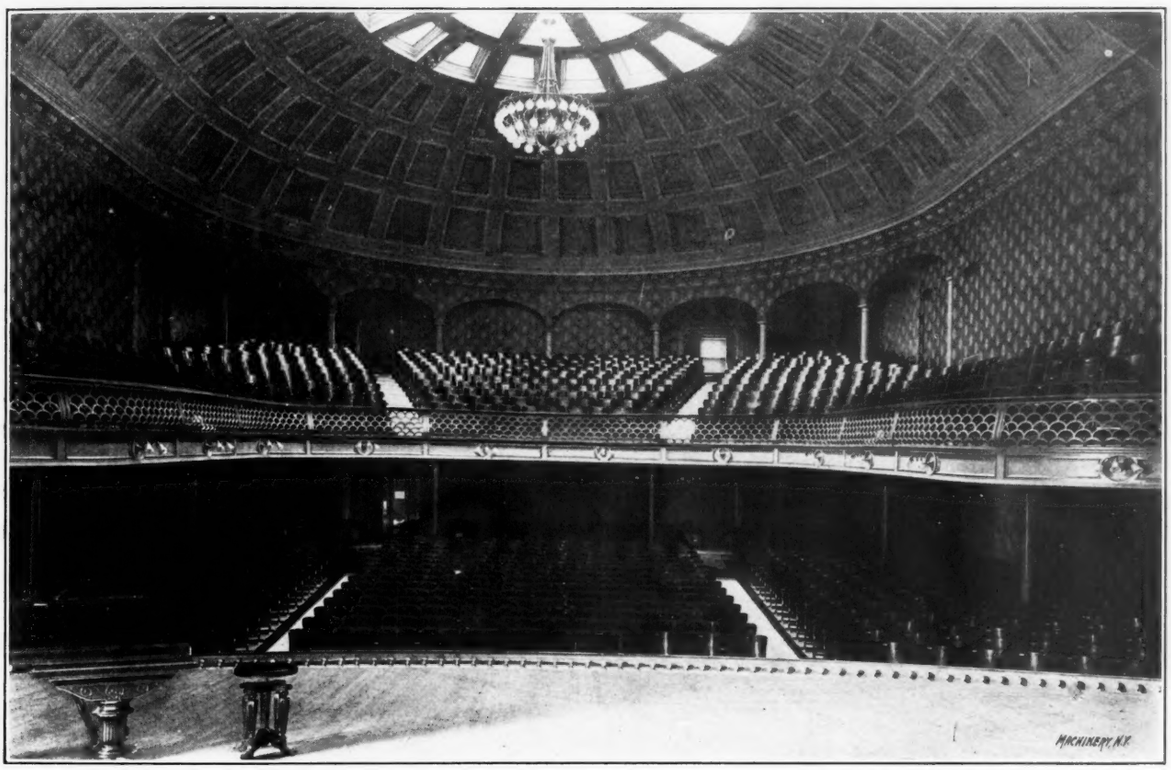
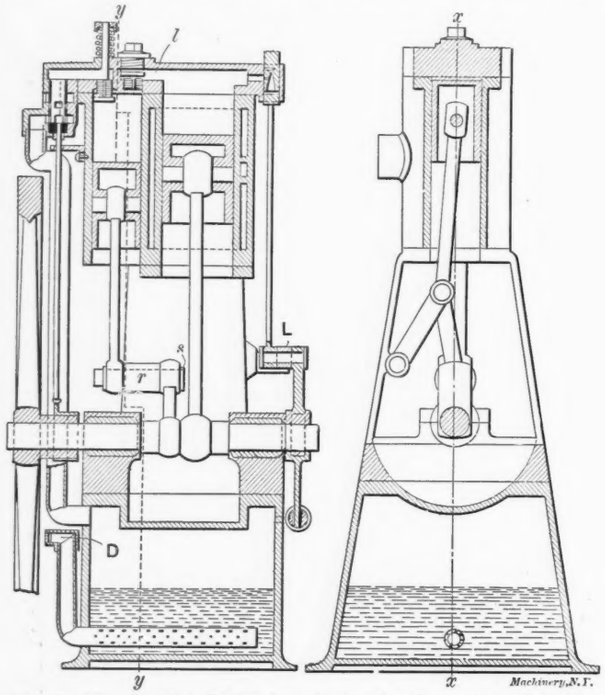


Fig. 5. Music Hall, an Auditorium in the Club House, which Seats about 1200.

This old-time experimenter also claims in this patent to be the original inventor of the water-jacketed cylinder; also of the injection of small quantities of water into the cylinder to assist the lubrication of the piston; of the auxiliary reservoir of compressed air for starting the engine; and of a liquid fuel vaporizer heated by the jacket water, including a very simple and effective device by which the proper supply of the liquid fuel is automatically controlled. This venerable inventor used turpentine for fuel, but on account of the high price of the article and the extravagant manner in which his engine consumed it, the old gentleman probably gave up in despair and abandoned his engine as a vain device. The Dugald Clerk engine forced a charge of air and gas into the cylinder at each revolution by means of a pump or separate charging cylinder, a system of construction which was subsequently followed by Riher, Beechy, Sintz and others. The Sintz patent of 1886 is fairly representative of this class, and is shown in Figs. 1 and 2. The small cylinder seen on the left in Fig. 1 is the pump

or charger which delivers a charge of carbureted air to the power cylinder at each revolution. In the base of the engine may be seen a form of the familiar surface carbureter. The system upon which this class of engine is constructed is not often adopted by modern designers, especially when the object is to secure an engine of few parts suitable for high speeds; but the system is nevertheless capable of successful application and might be used to advantage in some cases.

The compound gas engine of G. W. Daimler, patented December 9, 1879, No. 222,467, is shown in Figs. 3 and 4. This engine had two initial explosion or high-pressure cylinders which operated on the four-cycle principle and alternately delivered their exhaust gases to a third cylinder of larger size located between the other two; in this way securing two impulses at each revolution, and thus constituting a double-acting high-



Figs. 1 and 2. The Sintz Gas Engine, with Auxiliary Compression Cylinder.

compression compound gas engine, and moreover one in which the reciprocating parts are in balance. The high-pressure pistons, connecting rods and cranks are together just equal in weight to the corresponding parts of the low-pressure engine. The high-pressure cranks are in line with each other and diametrically opposite the low-pressure crank, so the opposing forces are in perfect mechanical balance and the engine will therefore run at any speed without vibration.

Another patent, Fig. 5, is that of L. H. Nash, May 22, 1883. This patent has expired and is useful as a precedent for the principle of operation known as continuous combustion. In this system the gas and air are first compressed to a high degree by separate pumps and delivered to the power cylinder as shown, during either a part or all of the power stroke. There is no explosion, but merely a continuous burning of the gas as it enters the cylinder, and by the heat of which a small amount of air is enormously expanded and the original pressure maintained.

Fig. 6 shows the cylinder and piston of a two-cycle engine which is said to have originated in England some years ago, and is known as the Loyal motor. It is probably the simplest form of reciprocating gas engine. The piston receives an impulse at each revolution of the shaft, and the engine automatically exhausts, inspires and strongly compresses a new charge in an open-ended cylinder without either mechanically-operated valves or an enclosed crank case, and without

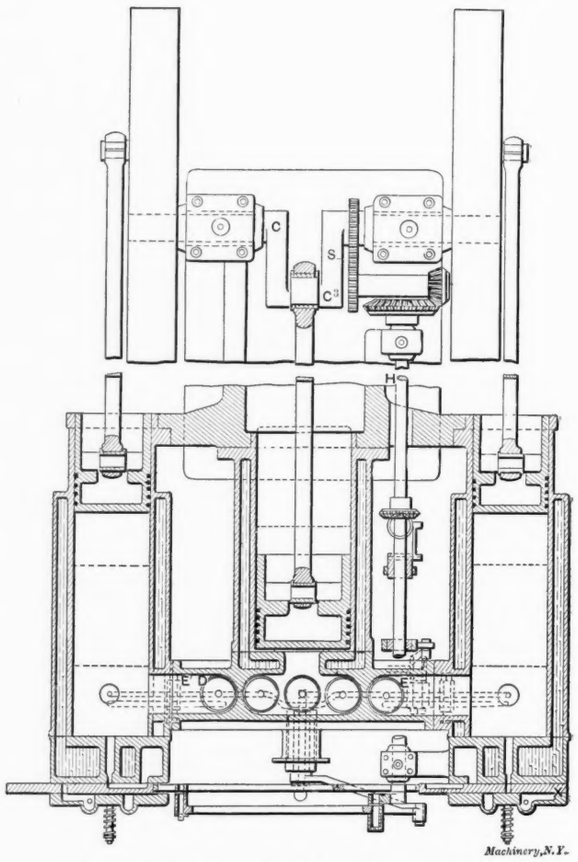


Fig. 3. Cross-section of the Daimler Compound Engine.

preliminary compression. It is, in fact, a veritable wonder. In the figure, *a* is the piston, *b* the inlet valve, and *c* the exhaust port. This port includes a self-acting valve not shown in the drawing, but which is similar to the inlet valve except that it opens outwardly.

The operation is as follows: Suppose the piston to have reached the limit of its instroke, indicated by the dotted line *d*. The charge is then fired and the piston goes forward on the power stroke, passing and uncovering the exhaust port through which the spent charge passes, forcing open the exhaust valve and escaping to the atmosphere. As the piston proceeds, a partial vacuum is formed behind it, opening the inlet valve and admitting a fresh charge. When the piston has arrived at the end of the power stroke, as shown in the drawing, and starts to return, the exhaust valve again opens and discharges

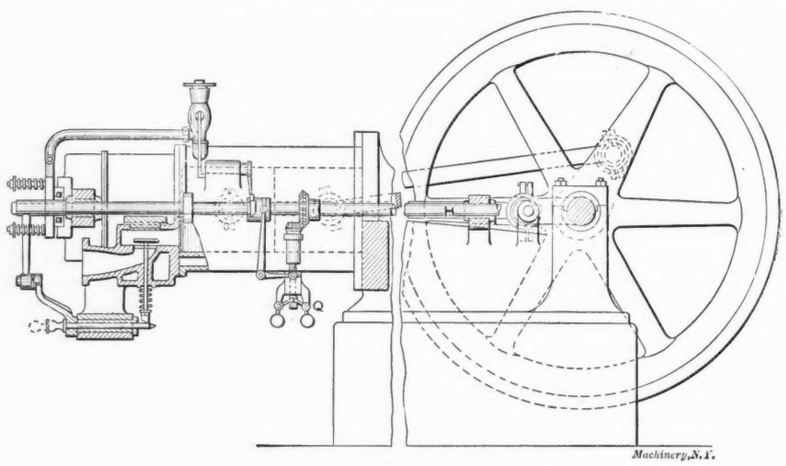


Fig. 4. Elevation of the Daimler Gas Engine.

the remaining portion of the burnt charge until the closure of the exhaust port, the piston continuing its inward motion and compressing the fresh charge to the termination of the instroke, ready for another power impulse, and so on in continuous operation.

This system is subject to several modifications and has frequently been designed without valves, the admission and exhaust being effected by piston-operated ports. An engine of this kind has been used to propel an automobile, but its inherent defect is the fact that the exhaust must take place at a time when the piston is moving at its most rapid rate. The system is therefore not suited to high speeds.

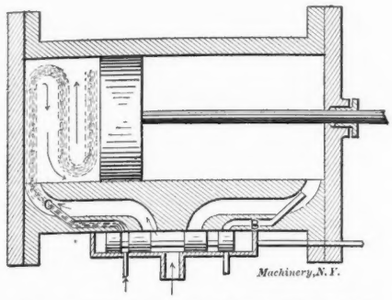


Fig. 5. Nasn Continuous Combustion Engine.

Fig. 7 shows a method of constructing a four-cycle double cylinder engine in which the cylinders are placed on diametrically opposite sides of the shaft and in the same axial center line; by this arrangement the reciprocating parts are to a certain extent in equilibrium, but the balance is of course not complete. This system of construction is very successfully used, however, by at least one firm in this country.

In the last paper we referred to the Nash two-cycle engine patent of July 17, 1888, No. 386,211, as here shown. The original application for this patent was filed November 5, 1885, but withheld from issue by the inventor for nearly three years, and kept alive by annual renewals. This was presumably for the purpose of extending the life of the patent or of postponing its appearance until the arrival of a more favorable time; somewhat after the far-seeing manner of that famous automobile inventor, Mr. George B. Seldon.

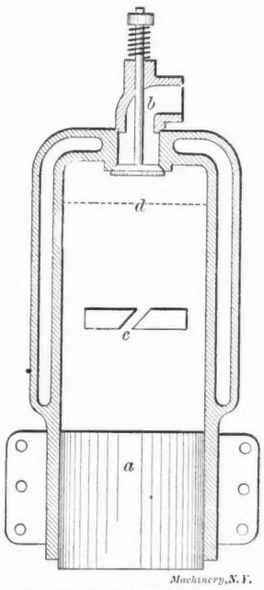


Fig. 6. The "Loyal" Motor.

This Nash patent contains six claims which are devoted exclusively to the construction of the piston deflector and a co-acting part of the combustion chamber, by means of which the entering charge is so directed and conducted as to force out the burnt gases of the previous explosion without mixing therewith. In regard to the enclosed crank case, the inventor terms this the compression chamber, and merely refers to the same as a cheap and simple method of construction; notwithstanding this fact, however, this patent is apparently the first instance of a two-cycle engine constructed with an enclosed crank case for the purpose of preliminary compression. The inventor's reason for not including the same in his claims doubtless was that a similar construction had been previously claimed by him in his four-cycle engine patent of 1883, No. 289,019, illustrated in our first paper.

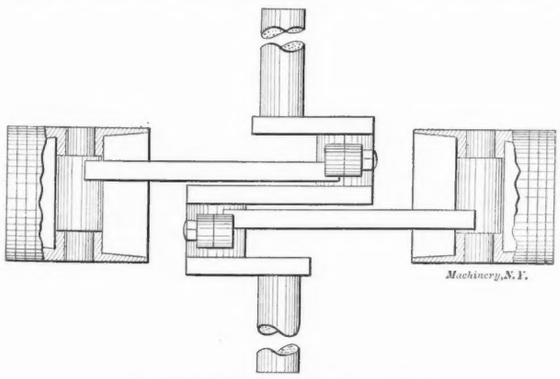


Fig. 7. Balanced Crank Construction.

In the case we are now considering the drawings show three modifications of the piston deflector and combustion chamber arrangements. Figs 8 and 9 show the first form of construction. Fig. 10 is a cross-section taken on line *x x* of Fig. 8. Fig. 11 represents the second form of construction. Fig. 12 is a cross-section of Fig. 11, on line *y y*. Fig. 15 is a cross-section of Fig. 11, on line *z z*. Fig. 14 shows the third method of constructing the combustion chamber and piston deflector. Fig. 15 is a cross-section of Fig. 14. These drawings are sufficiently clear to be self-explanatory and a detailed description is therefore unnecessary here.

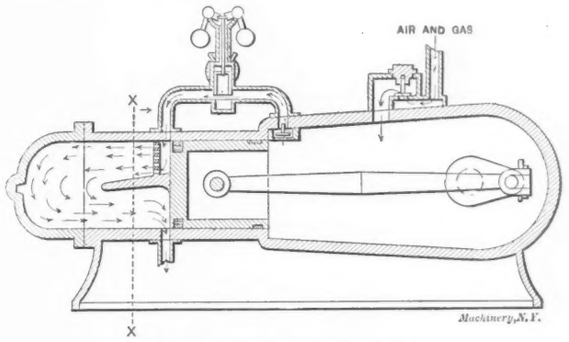


Fig. 8. The Nash Two-cycle Engine.

Regarding the relative merits of the three modifications, the inventor says that for small engines either of the two forms first shown are suitable, but in large engines the heat of the burning charge is too great to admit of the use of these means, and therefore in engines of large size the last-named modification is preferable.

In the conception of this invention it is a remarkable fact and seems to be an instance of strange oversight that Mr. Nash constructed his engine with the cylinder admission and exhaust ports on the same diametrical line, to be opened simultaneously at the last part of the power stroke, depending on a check valve in the transfer passage to prevent the exhaust from entering the crank case and back firing the new charge. Had the cylinder of this engine been constructed with the exhaust port in advance of the cylinder inlet port in the direction of the piston travel on the outstroke, thus permitting the exhaust to escape prior to the uncovering of the cylinder inlet port, the inventor would have produced a better engine and completely anticipated a strong point in subsequent inventions; but regrets are in vain.

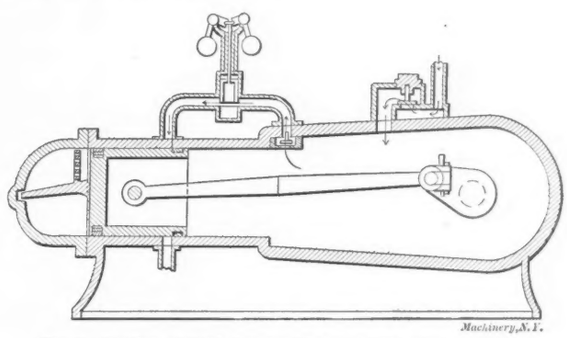


Fig. 9. Section of Nash Engine, Piston at Inner End of Stroke.

The above description completes the list of five patents named in former papers as furnishing the elements from which modern two-cycle engines are designed. The two-cycle engines best suited to the requirements of automobile service, however, are constructed upon what is known as the three-port system. In this system there is a crank-case inlet port so situated as to be uncovered by the outer end of the piston toward the end of the instroke and for a corresponding length of time at the beginning of the following outstroke. The exhaust and cylinder inlet ports are so located relative to each other that the exhaust will open first; the absence of the latter feature constituting the deficiency of the Nash patent already referred to. Patent law questions regarding the three-ported engine are

therefore limited to the ground covered by the Sintz, Day and Cock patents. The location of the exhaust port in advance of the cylinder inlet is shown in all four of the patents named, but is claimed only by Sintz. It is true that the English patents of Day and Cock are prior to that of Sintz, but I am informed by Mr. James Whitmore, of Detroit, Mich., that the

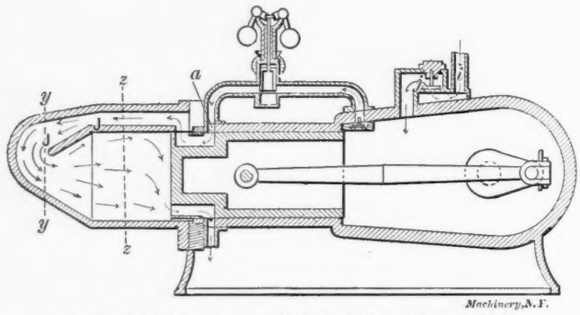
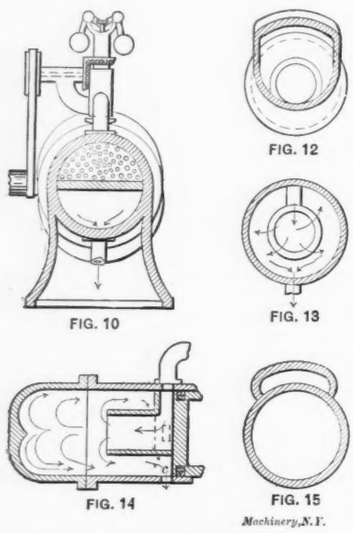


Fig. 11. A Modification in which the Piston acts as a Valve.

issue of the Sintz patent was preceded by an action in which Sintz proved his priority to Day. This fact would therefore place the advance exhaust port under tribute to the Sintz patent, but it must be admitted that the Sintz claim of this feature is only inferentially stated and is not so definite and emphatic as its importance would seem to warrant.

In regard to the crank-case inlet port named above, this feature is contended only in the Sintz and Cock patents, which, however, contain the said port in different forms. But as the Cock patent is based upon an English issue which preceded the Sintz application, the Cock patent therefore controls this feature, and while the three-ported engine is subject to the limitations of both the Sintz and Cock patents the claim for it in the Cock patent is weakened by the so-called dual or double arrangement of separate gas and air inlets. The Day patents have become non-effectual, owing to the expiration of the English patents, and the Cock patent will expire on October 15, 1906, for a similar reason. The Sintz patent will expire on Nov. 21, 1910.



Cross-sections of Figs. 9 and 11.

The law mentioned in the first paper of this series to the effect that the grant of a United States patent is void, if based on an application filed more than twelve months after the filing of a foreign application, was not in force when the Day and Cock applications were pending.

* * *

The development of the automobile has produced a power plant, capable of generating, say, 50 horse power, that can almost be packed away in a good-sized Saratoga trunk, but the cost of the fuel—gasoline—is practically prohibitive for almost all commercial vehicles. The rapidly increasing consumption and the fact that the newer oil fields are not producing oils rich in the lighter products such as gasoline, do not promise any cheapening in price but much rather a material advance. The alternatives are alcohol free of government tax and the portable gas producer plant. What is needed in the latter is a producer that shall be light, safe and reliable with the minimum of skilled attendance. There is already a big field open for the portable producer on motor boats where the question of weight is not so important as on the automobile. The ultimate development of the railway motor car will also require the gas producer.

THE PROBLEM OF TOUCHING CIRCLES.

A. L. DE LEEUW.

In the issue of March, 1906, I notice in the "How and Why" column, a statement by the editor, to the effect that no accurate and simple solution has been proposed for the problem of describing a circle which shall touch three given circles. I hate to "butt in," but can't help saying that, to the best of my knowledge, this very solution was proposed some 2,500 years ago. I wasn't there myself, and, therefore, cannot vouch for the exact date; but I remember having read a good description of it when I was a boy, which is several years ago though not quite 2,500. The trouble with this problem is not so much that it is a difficult one, as that it depends on the solution of another problem, and this again on the solution of still another. All of these problems are simple enough taken separately; but one has to go through the whole series, to come to a simple solution of your problem in No. 14.

The following three problems must be solved:

No. 1. To describe a circle, which shall touch a given circle, and go through two given points.

No. 2. To describe a circle which shall touch two given circles, and go through one given point.

No. 3. To describe a circle which shall touch three given circles.

For problem No. 1 see Fig. 1, in which A is the center of the given circle; O is the center of the circle to be described;

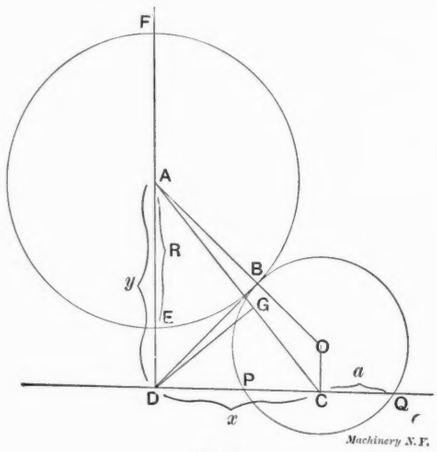


Fig. 1.

B is their point of contact; P and Q are the points through which the circle to be described must go. In order to analyze this problem, the diagram is drawn as if the circle to be described were already found. The line $Q\,P$ is drawn until it intersects the common tangent $B\,D$ of the two circles. From this point D a line is drawn to the center A of the given circle. This line intersects this circle in the points E and F.

As is well known to all who have ever studied geometry,

$$D\,P \times D\,Q = \overline{D\,B}^2$$

Similarly

$$D\,E \times D\,F = \overline{D\,B}^2$$

so that

$$D\,P \times D\,Q = D\,E \times D\,F$$

C is the center of line $P\,Q$. The length from this point to D is called x. The length of cord $P\,Q$ is called $2a$, so that $D\,P = x - a$, and $D\,Q = x + a$. The radius of the given circle is called R; and the distance from D to A is called y; so that $D\,E = y - R$ and $D\,F = y + R$. Substituting these values in the equation found above, we have:

$$x^2 - a^2 = y^2 - R^2$$

or

$$y^2 - x^2 = R^2 - a^2.$$

Drawing the line $A\,C$ and the perpendicular to that line at point D, we also know that $x^2 - C\,G^2 = y^2 - A\,G^2$

or

$$A\,G^2 - C\,G^2 = y^2 - x^2,$$

so that as $y^2 - x^2$ also equals $R^2 - a^2$

$$A\,G^2 - C\,G^2 = R^2 - a^2$$

from which

$$A\,G + C\,G : R + a = R - a : A\,G - C\,G.$$

In this last equation, all lines are known, except $A\,G - C\,G$. The length of this line can be found by construction, as it is the fourth proportional to $A\,G + C\,G$, $R + a$, and $R - a$. This will locate the point G.

Having found this point, G, we now proceed as follows: Erect a perpendicular to $A\,C$ in the point G. This line intersects the line $Q\,P$ in a point D. From this point D draw the tangent to the given circle A. The point of contact B will be also a point of the circle to be described. The problem

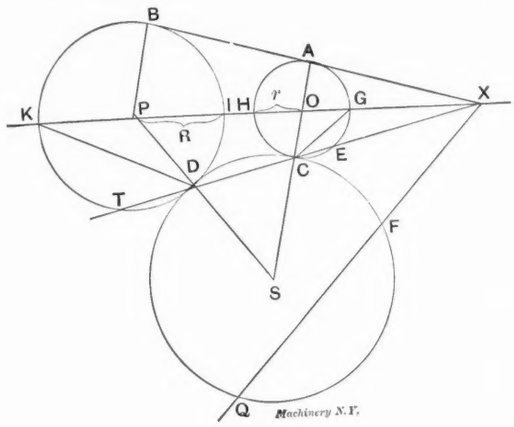


Fig. 2.

is now reduced to the problem of describing a circle which shall go through three given points, B, P and Q. As the solution to this problem is even older than 2,500 years, I will assume that it has become known by this time.

We now come to problem No. 2. (See Fig. 2.) O and P are the centers of the given circles; and Q is the given point. In order to come to a solution of this problem, we will analyze it by assuming again that the circle to be described has been found, and that its center is S. We draw the common center line, $O\,P$, and also the common tangent, $B\,A$, of the two given circles. These two lines intersect in the point X.

The points where the circle to be described touch the other circles, are called C and D. It is a well-known proposition that the line $C\,D$ goes through the point X. Drawing the lines $C\,G$ and $K\,D$, we find that triangles $X\,C\,G$ and $X\,K\,D$ are similar, because they have one angle in common, and the angles $X\,C\,G$ and $X\,K\,D$ are equal as they are measured by equal arcs:

$$\therefore X\,C : X\,G = X\,K : X\,D \text{ or}$$
$$X\,C \times X\,D = X\,G \times X\,K.$$

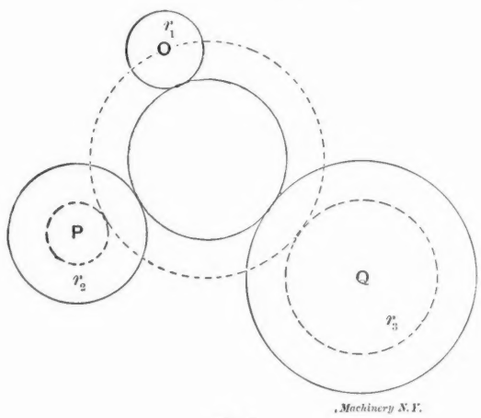


Fig. 3

We know further that $X\,C \times X\,D = X\,Q \times X\,F$, as $X\,C\,D$ and $X\,F\,Q$ are secants of the same circle, so that $X\,G \times X\,K = X\,Q \times X\,F$. In this last equation $X\,F$ is the only unknown quantity, and it can be found as the fourth proportional to $X\,Q$, $X\,K$ and $X\,G$. Having found this point F, the problem is reduced to the first problem, namely, to describe a circle, which is to touch a given circle, and which is to go through two given points.

Now consider the original problem. (See Fig. 3.) O, P and Q are the centers of the given circles, and their radii are $r_1 - r_2$ and r_3. We describe circles with P and Q as centers, and with radii equal to $r_2 - r_1$ and $r_3 - r_1$ respectively. We then describe a circle, which touches the two new circles and which goes through the point O, working backward through problems No. 2 and No. 1. The center of this circle will be the center of the required circle.

Stripped from all demonstration and analysis, the solution is not complicated, and can be carried out by means of straight edge and compasses. No calculations are required. There are eight circles which fill the requirements: one, making external contact with all three circles; three, making external contact with two circles, and internal contact with one circle; three, making external contact with one circle, and internal contact with two circles; and one, making internal contact with all three circles.

The particular case of question, No. 14, is simpler, because two of the circles have the same diameter. This reduces the even circles to points, while the third circle becomes a negative one. Now a negative circle must look rather like a queer thing, but as a matter of fact, it simply means that the circle to be described will make internal contact with that third circle and go through the centers of the other two. This particular case, therefore, skips one problem, and brings it down at once to problem No. 1.

Though the editor did not say so, I believe that he meant, that no simple solution has been proposed so far for the *calculation* of diameter and location of the circle which touches three given circles. If he meant this, then I agree with him. The fact that eight circles are possible, indicates that an equation expressing the location or diameter, would be of the eighth degree at least, and such an equation must be of a very special form if it shall be susceptible to direct solution.

* * *

Some months ago we gave a short editorial comment on unskilled labor, in which it was pointed out that unskilled labor, as such, was practically an unknown quantity. But, unfortunately, the skill which a laborer possesses in digging earth or in the handling of pig iron or shoveling coal is that which he has secured by experience and little of it is due to instruction. That it is possible to greatly increase the efficiency of laborers by instruction is interesting, but that in some classes of work it is possible to quadruple their efficiency is hardly believable. The skill of laborers in handling pig iron or shoveling coal consists only in lifting the greatest amount per day with the least effort, for his effective energy is strictly limited and must be conserved carefully, as otherwise he will be exhausted before the end of the day's work. In investigations conducted by Mr. Frederick W. Taylor along these lines it was found that most laborers waste considerable of their effort by false moves. For example, in unloading pig iron from a car, which work requires the lifting of pigs weighing, say, about 90 pounds, carrying them to the edge of the car and throwing them overboard, there was found to be a lack of continuous effort. The laborer would stoop down, pick up the pig stand for a moment and then start for the side of the car. It was suggested that the movements should be co-ordinated so that the impulse required to pick up the pig should be continued until it was dropped over the side of the car. The surprising result was found that where an ordinary laborer had been able to handle only about twelve tons per day, under the new system he handled about forty-eight tons per day. Again, in the matter of shoveling coal, the shape of the shovel and its size were found to be very important factors, and by studying the problem the amount of coal that could be handled by the average laborer with no greater tiring than before was greatly increased. From this experience it is quite evident that the training of laborers may be quite as important as the training for the so-called trades. The training of the laborer, of course, will be more that of muscle training than of brain training, but it is nevertheless quite as important in the cost of production where large quantities of materials must be handled by manual labor.

* * *

The value of the expression $x^2 + x + 41$ is a prime number for all whole values of x up to and inclusive of 39.

THE CONCRETE ERECTING SHOP OF THE INGERSOLL MILLING MACHINE COMPANY.

An interesting example of reinforced concrete shop construction is shown in the accompanying half-tones and line cuts, being the new erecting shop built in 1904-05 by the Ingersoll Milling Machine Co., Rockford, Ill. The building is, at present, 199 feet long and 60 feet wide; the main bay or erecting floor is 40 feet wide and the top of the crane tracks is 30 feet from the floor. It is built entirely of reinforced concrete with the exception of the roof. Even the crane runway girders are concrete, the reinforcement details of these appearing in Fig. 4. The use of concrete was decided on because of the plentiful deposit of sand and considerable gravel which underlaid the site. This fact, together with the growing use of concrete for general engineering structures naturally influenced the company toward the use of this material which, of course, meant a cheaper structure than one built of brick and safer and more durable than if built entirely of wood. Mr. W. W. Crehore, of New York, prepared the plans for the concrete work and his specifications as regards the reinforcement are as follows:

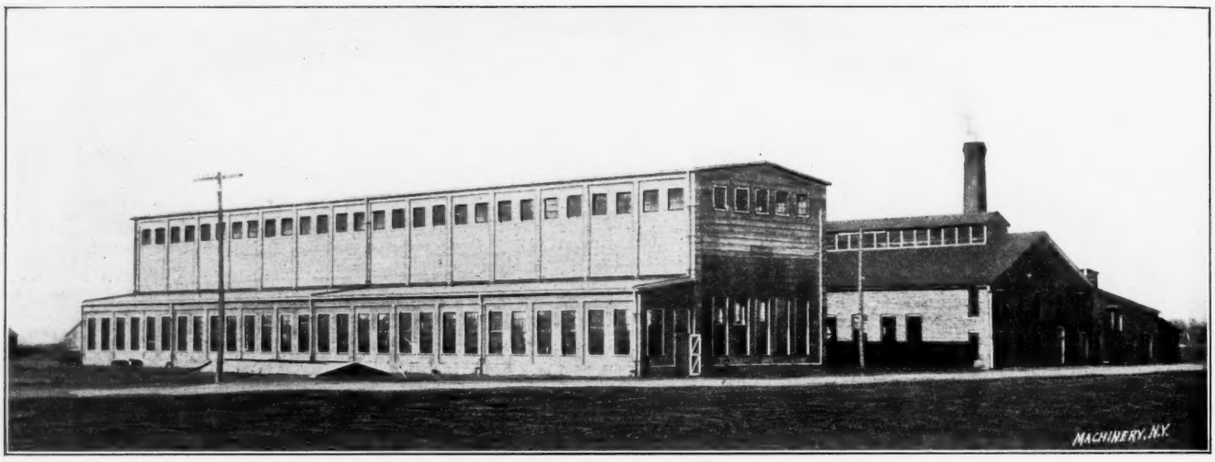


Fig. 1. The New Erecting Shop of the Ingersoll Milling Machine Company.

1. All rods shown, but not otherwise marked, are ¾ inch diameter.

2. All vertical corner rods in main piers and columns should have the ends squared to a true bearing where spliced. Splices for column rods shall be made of pipe sleeves—1-inch pipe for ¾-inch rods, and 1½-inch pipe for 1¼-inch rods. Each sleeve shall be about 16 inches long, and when set shall cover 8 inches of each rod spliced. After being set the space between the inside of the sleeve and the rods shall be filled with neat cement grout. (See illustration in Fig. 4.) Joints should alternate.

3. Double rods, either vertical or horizontal shall be banded together at intervals of 3 or 4 feet, but shall not be spaced so close together that they cannot be completely covered with concrete.

4. No rod shall be placed nearer than 1½ inch to the outside edge of the concrete in any direction.

5. Besides rods here shown there shall be, in the curtain walls all around the building, horizontal ½-inch rods and vertical ¾-inch rods about 3 or 4 feet apart.

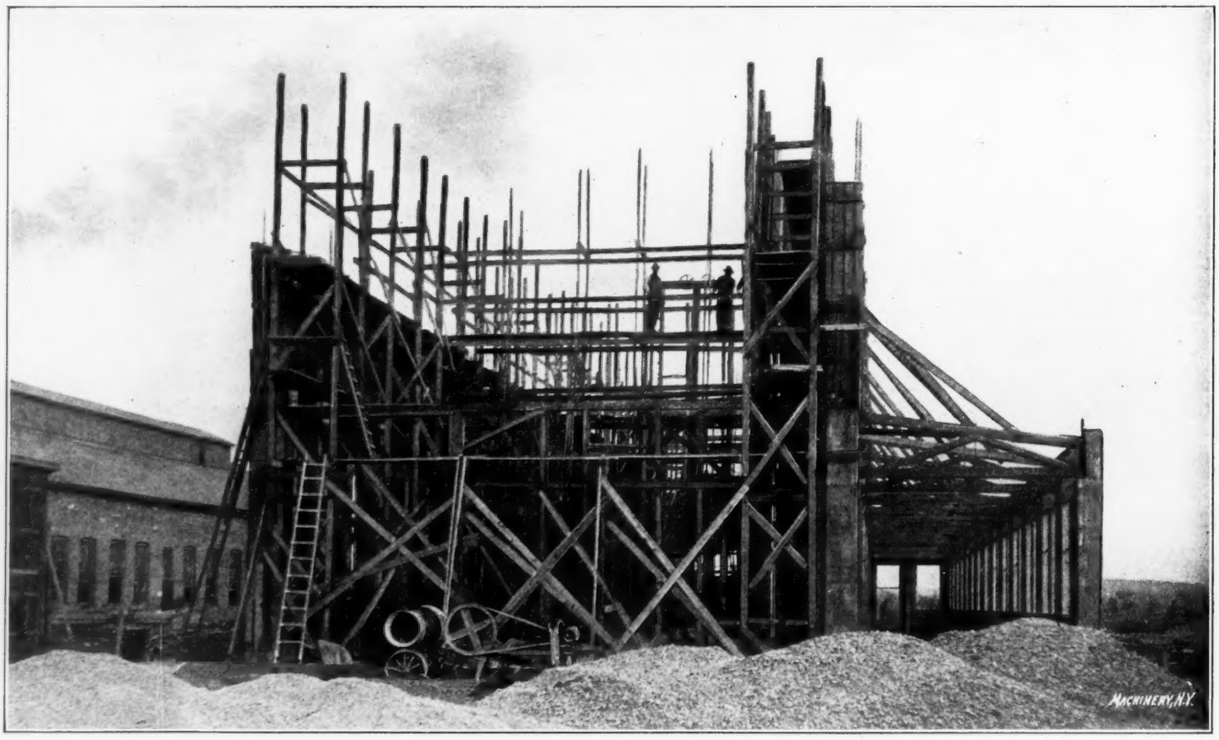


Fig. 2. Building the Concrete Walls, showing the Wooden Molds in place on the Upper Half of Wall.

6. There shall be no grease, oil, paint nor any foreign substance on the rods when set, and they should be scraped clean of all loose scale or rust. The surface need not be bright, however.

7. The concrete should be mixed just wet enough so that

it cannot be piled up. It should be put in the forms in small quantities, and thoroughly *stirred* to expel the air at once before beginning to harden.

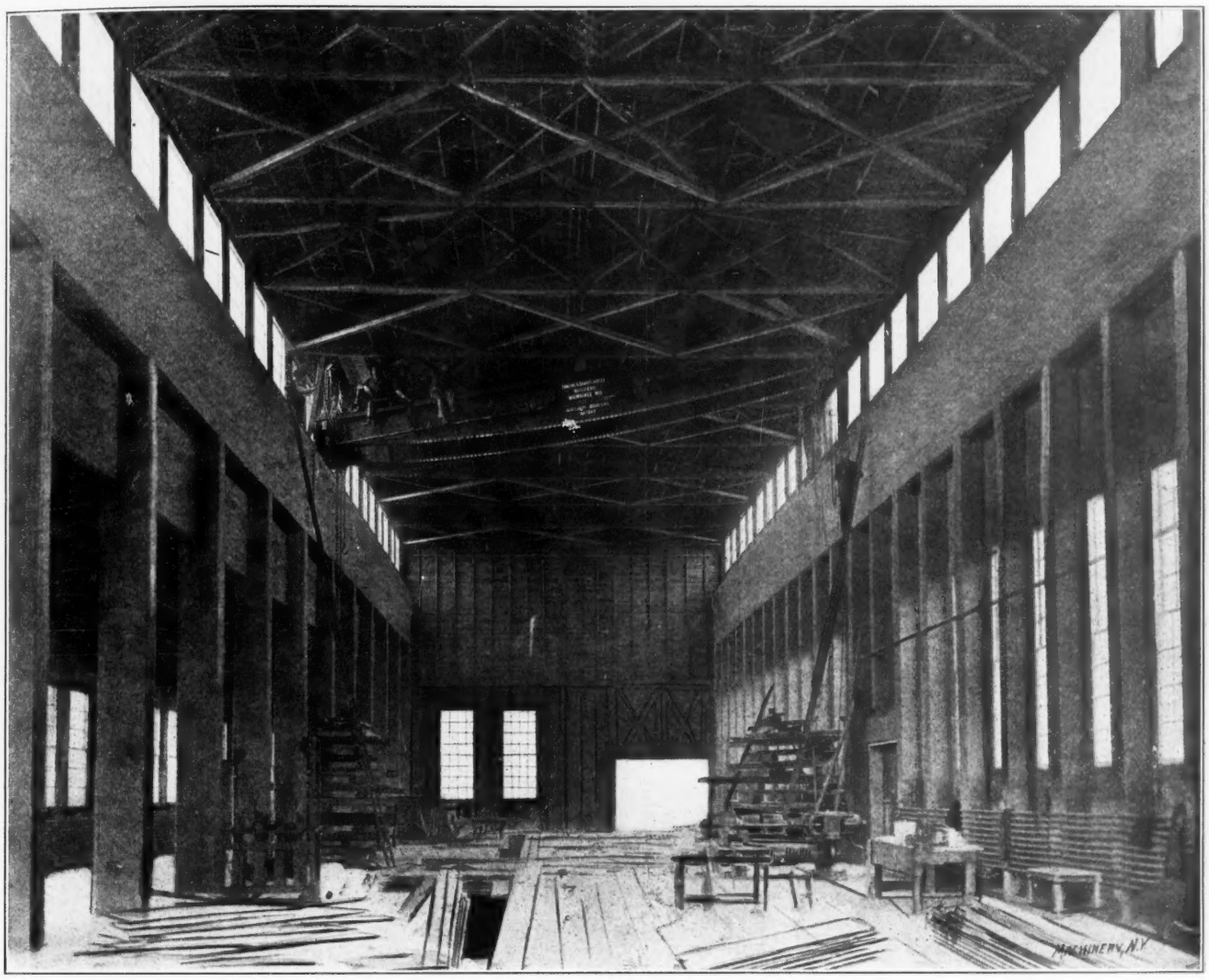


Fig. 3. Interior View taken while Crane was being Erected.

8. No concrete should be used after standing ready mixed for more than twenty minutes.

9. To prevent cracking or crumbling all concrete should be kept thoroughly wet until set solid.

10. To obtain a good bond and no voids around the iron rods, use no stone or gravel larger than ¾ inch in any dimension.

The proportions used in mixing the concrete were left largely to the discretion of the building superintendent, and were substantially as follows: 6 sacks of cement, 5 wheelbarrows of gravel or crushed stone, and 7 wheelbarrows of sand. It developed that not enough gravel was available from the company's gravel pit for the entire construction of the building, hence some crushed stone was used to complete the work; this was slightly larger than that specified, being of a size that would go through a 1-inch screen.

The interior of the erecting shop is shown in Fig 3 at the time of the erection of the 20-ton traveling crane. The crane tracks are supported in pilasters of concrete, the details differing slightly from the drawing shown in Fig. 5 in that the inner face of the pilasters and crane track are in the same plane instead of the latter overhanging three inches, as shown in the cut.

The wing or side bay is about 15 feet wide in the clear. It is used for workbenches and the general fitting work connected with erecting. The floor in the side bay is of concrete about 4 inches deep; in the main bay it is 10 inches deep. Large floor plates are made in main floor by railroad rails which are bedded in it, spaced about 3 feet apart. Over the pits these rails rest upon 14-inch steel I-beams and the space between is filled in with reinforced concrete 6 inches deep. The tops of the T-rails are ½ inch above the floor, and are drilled and tapped at short intervals for clamps. The details of the floor and pits are shown in Fig. 6. The pits are provided, of course, for convenience in erecting so as to permit the men to get beneath the machines as they rest on the floor. A passage connects these pits, making communication

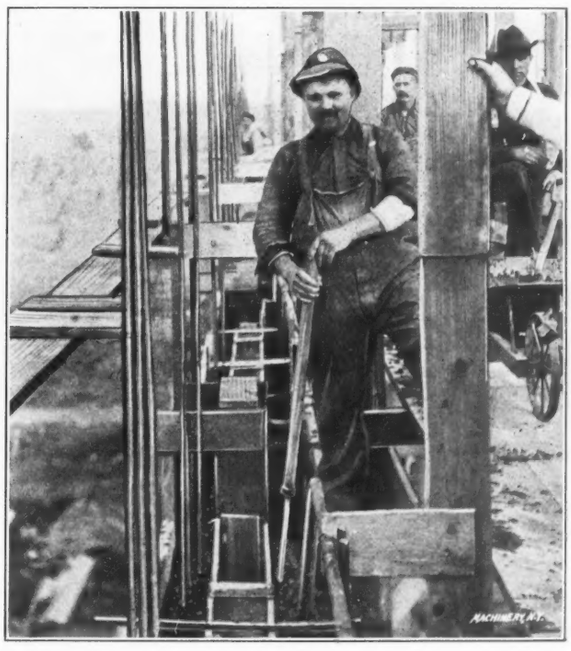


Fig. 4. Filling the Molds.

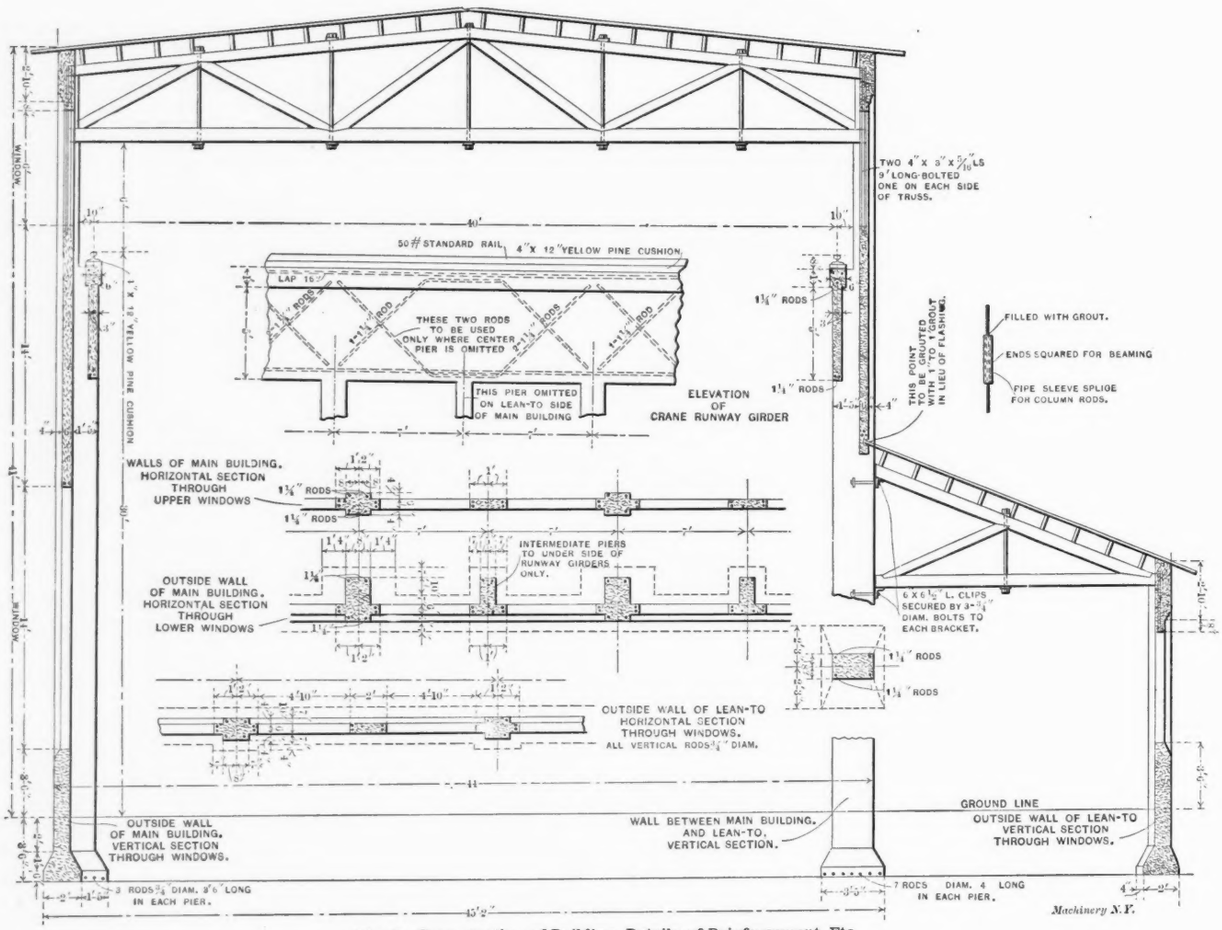

TWO 4" X 3" X 5/16" LS 9' LONG BOLTED ONE ON EACH SIDE OF TRUSS.
50# STANDARD RAIL
4" X 12" YELLOW PINE CUSHION
LAP 16"
THESE TWO RODS TO BE USED ONLY WHERE CENTER PIER IS OMITTED
THIS PIER OMITTED ON LEAN-TO SIDE OF MAIN BUILDING
ELEVATION OF CRANE RUNWAY GIRDER
1¼" RODS
FILLED WITH GROUT.
ENDS SQUARED FOR BEAMING
PIPE SLEEVE SPLICE FOR COLUMN RODS.
THIS POINT TO BE GROUTED WITH 1" TO 1" GROUT IN LIEU OF FLASHING.
WALLS OF MAIN BUILDING. HORIZONTAL SECTION THROUGH UPPER WINDOWS
INTERMEDIATE PIERS TO UNDER SIDE OF RUNWAY GIRDERS ONLY.
OUTSIDE WALL OF MAIN BUILDING. HORIZONTAL SECTION THROUGH LOWER WINDOWS
6 X 6½" L. CLIPS SECURED BY 3-¾" DIAM. BOLTS TO EACH BRACKET.
OUTSIDE WALL OF LEAN-TO HORIZONTAL SECTION THROUGH WINDOWS. ALL VERTICAL RODS ¾" DIAM.
OUTSIDE WALL OF MAIN BUILDING. VERTICAL SECTION THROUGH WINDOWS.
WALL BETWEEN MAIN BUILDING AND LEAN-TO. VERTICAL SECTION.
GROUND LINE
OUTSIDE WALL OF LEAN-TO VERTICAL SECTION THROUGH WINDOWS.
3 RODS ¾" DIAM. 3'6" LONG IN EACH PIER.
7 RODS DIAM. 4 LONG IN EACH PIER.
Machinery N.Y.

Fig. 5. Cross-section of Building, Details of Reinforcement, Etc.

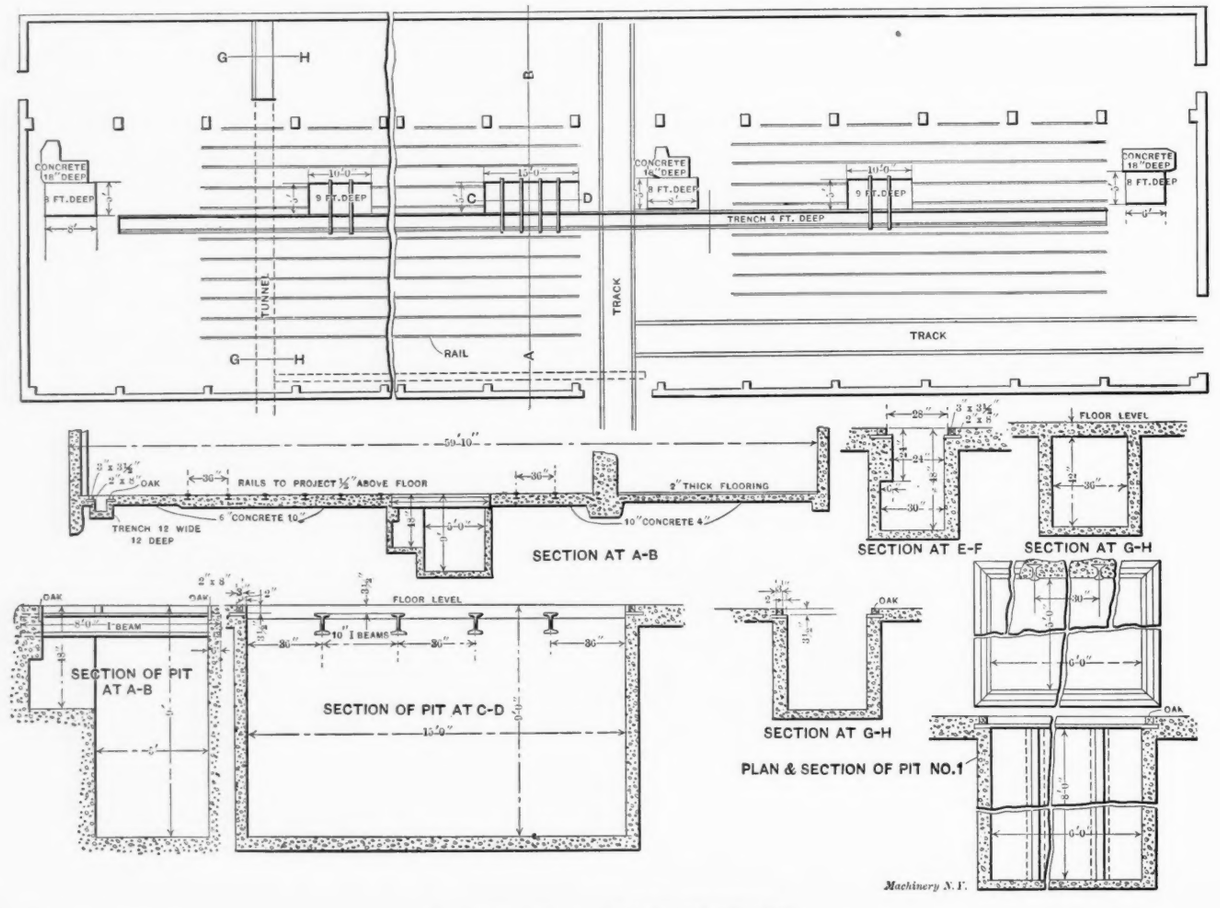


Fig. 6. Floor Plan and Details of Erecting Pits.

from one to another convenient and avoiding the necessity of climbing up upon the floor. A narrow-gage track made of 1¼-inch round iron is laid in the side bay to serve the workbenches. A transverse track leads into the machine shop through a covered passage connecting the two shops. This passage, in fact, is a connecting building and contains the tool room and wash room. The workbenches, by the way, are not set next to the outer walls as is the usual practice, but the space represented by the tracks separates them from the outer wall. Steam pipe coils are used for heating and these are located on the side walls below the windows. It is interesting to note that part of the concrete work of erection was done in the winter of 1904-5 when the thermometer was 15 degrees above zero, but by warming the sand, water and other material no trouble was experienced from freezing.

It is something of an anomaly in modern shop building to see a wooden superstructure used on concrete walls, but such is the case in this erecting shop. The roof is supported by wooden trusses which are strongly braced sidewise by diagonal struts between. These struts support the roof against the longitudinal surging stresses set by the traveling crane when suddenly started and stopped. There is no monitor in the roof, but windows high up in the sides admit plenty of light.

It may be a matter of wonderment on the part of some readers why a company building machine tools would require such a lofty erecting shop. We might say in explanation that this shop is in a certain sense an expression of the faith of Mr. Ingersoll in the milling machine and its future. And already one of the first erected in the new shop was the monster milling machine built for the Schenectady works of the General Electric Works which was illustrated in the November, 1905, issue. This tool, which will handle a cube measuring 10 feet and which weighs complete about 300,000 pounds, certainly required about practically the same shop facilities and space for handling as does the modern vertical compound steam engine of the larger powers. The present length of the erecting shop is 199 feet, but it is the intention to ultimately extend it to the same length as the machine shop, which is 312 feet 6 inches. In conclusion, we might mention what Mr. Ingersoll says in regard to the milling machine versus the planer in his own shop, and that is that he proposes to eliminate the planer entirely in his own work; in short, to take his own medicine to the limit.

* * *

At the fall meeting of the A. S. M. E., Mr. H. K. Jones told of his experience with the lubrication of line shafting at the Russell & Erwin plant of the Corbin Screw Corporation. In these shops there are about 3,000 feet of self-oiled shafting averaging about 2 7-16 inches in diameter and running from 150 to 500 revolutions per minute. Each of these pumps is "suction" oiled, some of them being provided with ring oilers at the ends as well. For many years "West Virginia native" oil was used, with entire satisfaction. A short time ago native oil becoming scarce, a black lubricant, a by-product of kerosene manufacture, was tried. This increased the friction by nearly 25 per cent, so the lubricant was changed to "engine" oil. This gave practically the same results as the "West Virginia native." A year or so ago, for the first time in thirty years, all the oil was cleaned from each hanger box. Apparently this cleaning had no effect on the amount of power necessary to run the shafting, so, since that time, the supply has simply been replenished occasionally without draining the reservoir. In a neighboring factory the shafting is supported by hangers with provision for both suction and ring oiling. An examination was made of these hangers and in many of them the oil had thickened and the rings stuck, but the wicking was working satisfactorily. The speaker showed a suction oil box which had been in use for thirty years on a shaft running at 300 revolutions per minute, much of the time working twelve or fourteen hours per day. Apparently the bearing surfaces were "good for at least 1,000 years," to use the speaker's words. The speaker's experience with these bearings, and others which have come under his observation, has led him to believe that the suction or capillary oiler is much more reliable than the ring oiler in the long run.

VARIABLE SPEED MECHANISMS.—9.

In this, the concluding article of the series on variable speed mechanisms, it may be of interest to make brief reference to a class of variable speed devices which was not mentioned in the general review of the art in the first article, May, 1905, and that is hydraulic variators. These devices resolve themselves essentially into some form of pump and motor, generally of the rotary class because of the obvious difficulty of making reciprocating motors work satisfactorily with a non-

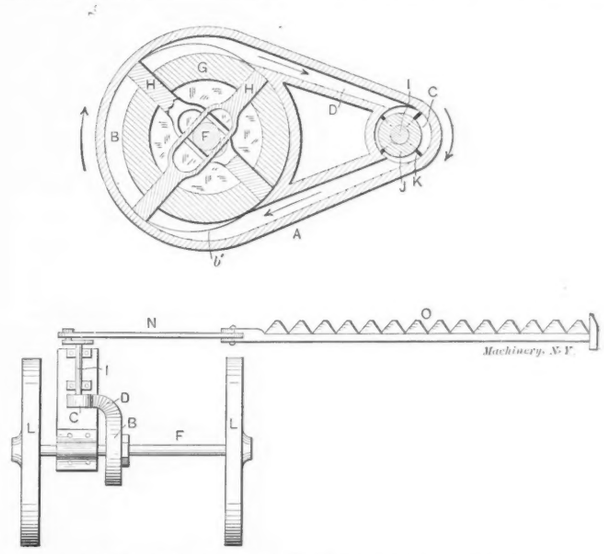


Fig. 76. A Mowing Mechine Drive, Patented by L. Lapyre, August 15, 1882 No. 262,794.

expansive fluid and, of course, a non-expansive fluid such as water or oil is necessary for efficient power transmission.

The idea of power transmission by a hydraulic medium using a rotary pump and motor to give a higher velocity ratio of the motor is illustrated in the views shown in Fig. 76. This device, patented by L. Lapyre, August 15, 1882, No. 262,794, is not a variable speed apparatus but is simply a device for multiplying the speed of the driven shaft and at the same time changing the angle. The lower view shows its application to a mowing machine. It is obvious that if the capacity of the pump *B*, in the sectional view, could be decreased and that of the motor *C* increased, or *vice versa*, at will, the relative velocity ratio of the two would be changed. This is the general principle on which the hydraulic variator should be constructed. But a large number of the devices patented for changing speed have worked on the by-pass principle illustrated, for example, in Fig. 77. This invention, patented by James W. See, June 26, 1883, No. 280,247, is called a device for transmitting motion. The patent specifications set forth the use of the shunt circuit *G* controlled by the regulating valve *H* through which the liquid may be diverted when it is desired to change the speed of the driven wheel *F*. The motor and pump, it will be observed, are each of the double mutilated gear type. The rotation of the pump *B* forces a definite amount of liquid through the circuit for

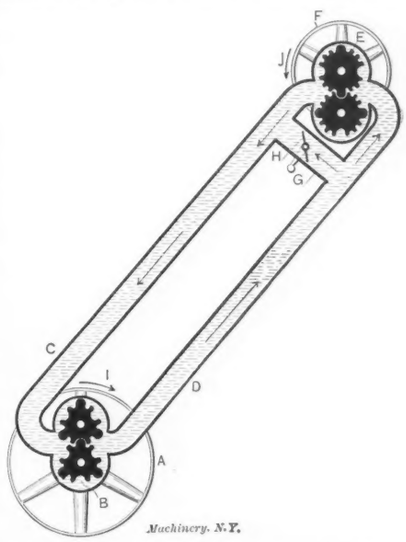


Fig. 77. The By-pass Idea, as Worked Out by James W. See, Patent No. 280,247, June 26, 1883.

each revolution. If it is desired to lower the speed of *F* the regulating valve *H* must be opened so as to allow a portion of the liquid to by-pass and thus avoid passing through the motor. It is obvious, of course, that this method of controlling the speed is wasteful of power and is, in effect, much the same as applying a brake to a flywheel.

Fig. 78 is an illustration of the true speed variator of the hydraulic type, although of doubtful practicability. It was patented by A. P. Thayer, October 10, 1876, No. 183,081. In this device the pump is of the reciprocating type while the

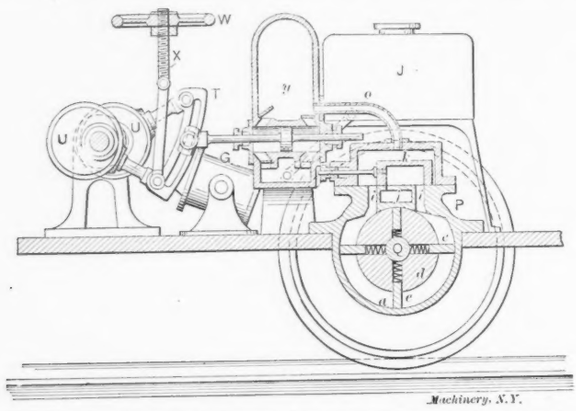


Fig. 78. Patent No. 183,031, granted to A. P. Thayer, October 10, 1876.

motor is of the rotary type, having radially moving vanes which move inward and outward when passing the abutment *J*. The stroke of the reciprocating pump is controlled by the position of the link *T*, this link being driven by two eccentrics *UU*. Raising the link by the hand wheel *W* shortens the stroke of the pump and slows down the motor. This part of the device, of course, is designed on the principle of the well-known Stephenson link motion. The function of the

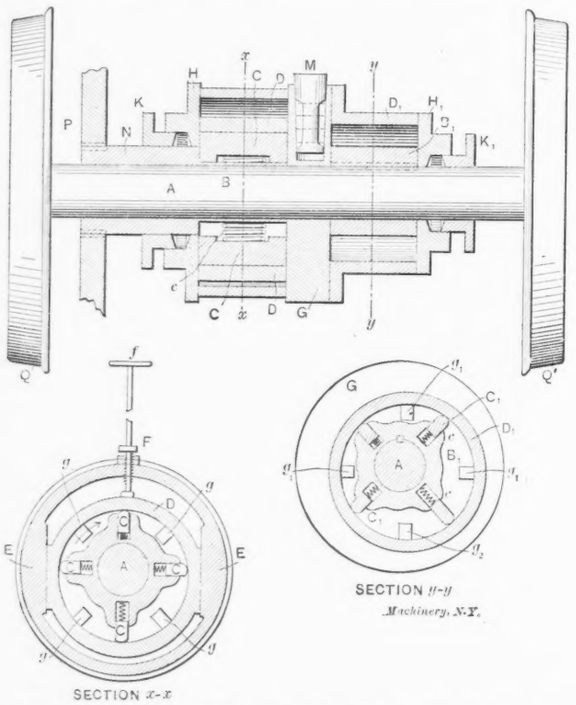


Fig. 79. Hydraulic Variable Speed Gear applied to Car Axle. Patent No. 463,660, granted to Louis Duncan, January 5, 1892.

slide valve *K* is that of reversal only. The cylinder shown at *G* is one of a pair of oscillating steam cylinders which drive the eccentric shaft.

Patent No. 466,660 was granted to Louis Duncan, January 5, 1892, for a hydraulic variable speed gear in which the capacity of the pump only, as shown in the cut, could be varied, but provision was made for varying the capacity of both the pump and the motor if such range is needful. The cut, Fig. 79, shows its application to the axle of a car. Section *x x* shows a section through the pump and section *y y* through the motor. The connection of the pump to the driving power is not shown. The valve *M* is for reversal of the motor, being in effect a two-way cock which transposes the closed circuit so as to effect reversal when required, or closes the connection between the pump and motor and short circuits the path of each. The springs shown at *B* and *c* are for holding the shell *D* against the controlling screw *F*. By screwing the case *D* up or down, the eccentricity of the shell with the shaft *A* is changed and consequently the capacity of the pump. The inlet and outlet ports are shown at *g* and g_1.

A patent was granted for an automobile vehicle December 19, 1899, No. 639,541 to F. S. and L. H. Dyer, and one feature of the invention is a variable capacity pump driven by an explosive motor. The pump was designed to circulate a variable column of water, oil, glycerine or other suitable liquid through a rotary motor, the variation in amount pumped increasing or decreasing the speed of the driving wheels. Fig. 80 shows the pump, the shaft *C* being connected to the crankshaft of a gasoline engine. To the end of the shaft *C* is keyed a spherical sector *A*, which is fitted in a spherical shell *G*. Opposing the

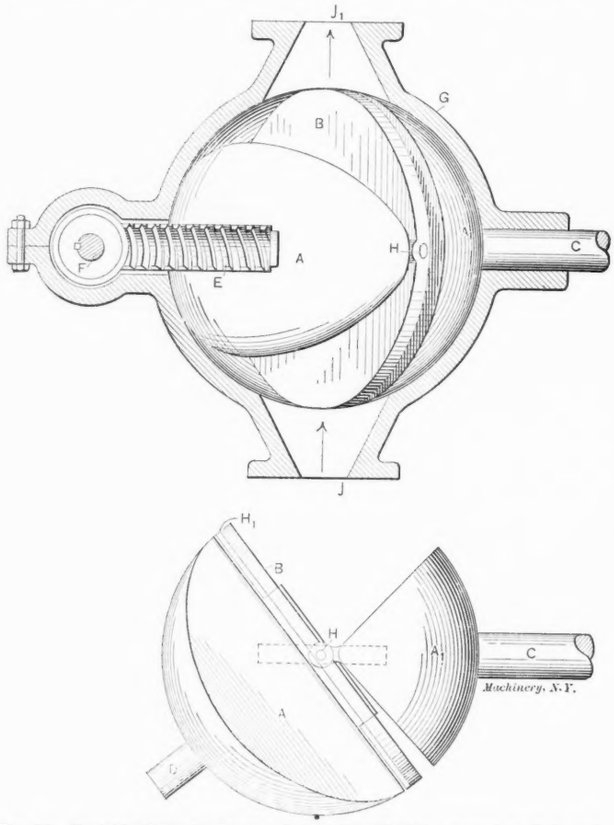


Fig. 80. Variable Capacity Pump. Patent No. 639,541, granted to F. L. and L. H. Dyer, December 19, 1899.

sector A_1 is another sector *A* and between the two is a movable wall or diaphram *B* made in the form of a circular disk and hinged to both *A* and A_1. The sector *A* has a short section of shaft *D* which acts as the pivot for its rotation. This pivot has a seat in the section of wormwheel *E*. *F* is a worm for changing the position for the mutilated wormwheel and of the pivot *D*, consequently when the shaft *D* and *C* are in line the two sectors and the disk *B* rotate idly without displacing liquid but upon changing the angular position of *D*, rotation of the sectors gives a wabbling motion to the disk *B*, causing expansion and contraction of the spaces between the sectors and the disk. The greater the angular displacement of *D*, the greater is the pumping action. The inlet and discharge ports *J* J_1 are so formed and located so that they serve both sides of the disk, two chambers drawing in and two discharging at the same time.

Fig. 81 shows a variable speed transmission patented by C., W. and S. Hibbard, June 7, 1904, No. 762,055. Only the side view of this invention is shown. There are three pumps, the cranks or eccentrics for which being indicated at *C* C_1 C_2.

They all discharge into a common chamber from which the stream may be diverted in either of two directions in driving the rotary motor *N*, so as to effect reversal. The water after passing through the motor is returned to the tank and used over and over again, the same as in a closed circuit. The capacity of the pumps is changed by changing the position of the fulcrum *E*, one of which is provided for each walking beam. These fulcrums are on the ends of cranks mounted on a shaft which has a handle on the outside of the tank. By throwing the point *E* closer to the pump, the throw is shortened, and *vice versa*.

It is unfortunate that the hydraulic principle of speed variation has not received more attention than apparently has been bestowed upon it. Apparently no really practical and efficient

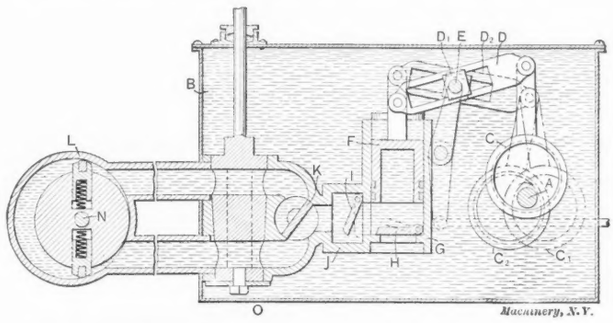


Fig. 81. Patent No. 762,055, granted to C. W. and S. Hibbard, June 7, 1904.

device has ever been brought into common use. We say that it is unfortunate because the principle of speed variation by changing the capacity of the pump or motor, or both, is one that permits of the finest relative adjustment of velocity ratio and it should be capable of effecting these changes with very simple construction. Leakage, of course, is the bane of all such devices, but with modern tools and methods of construction it would seem quite possible to build pumps of the rotary class that would be efficient, both in the matter of frictional resistance and freedom from leakage.

* * *

THE DESIGN OF BILLET AND BAR PASSES.

B. H. REDDY.

In practice, engineers and designers usually make use of methods for arriving at conclusions which are particularly adapted to their line of work. These methods may be original with themselves or they may be the methods of others modified to suit the requirements of their own particular practice. In the original design of work it is frequently very desirable that approximate results first be obtained in order that an idea may be formed of the best way in which to produce the desired results. In different lines, the work and plans of the engineer, however broad and thorough he may be, are very frequently subject to changes galore by the men who are familiar with the practical features and peculiarities and who are directly concerned in the repair and operation of the plant in process of development. During the discussions or conferences between the different men interested, short methods are especially desirable for quickly arriving at approximate results, and in the hope that it will prove of value to those who are interested in the design of billet and bar rolls, the writer will give a description of a method by means of which a series of such passes may be quickly proportioned.

Determining the Number of Passes.

In the designing of roll passes in general it is necessary that the sizes and shape of the finished product be known. The product being decided upon, the number and proportions of the passes, and the dimensions of the bloom or slab to be used must be fixed according to circumstances. The first feature to demand attention will quite likely be the number of passes the material will have to make through the rolls before being brought to the dimensions required. If the rolls are to be designed for a mill already existing this will depend upon the strength of the mill, the number of passes available in that mill, etc. On these limiting circumstances, and also on the available supply, will depend in a large measure the size of bloom or billet which can be used. When designing rolls for a new layout the conditions mentioned above do not apply, as the arrangement of the new mill will depend very largely on the product desired.

It is desirable first that the number of reductions or passes be at least approximated, depending, of course, on the shape of the section to be rolled, etc. By reduction is meant the difference between the area of cross section of the billet before passing through the rolls and after passing through, divided by the original area. For example, if a 4 x 4 billet becomes 2⅝ x 4¼ after passing through the rolls the reduction would be found thus:

$$(4 \times 4) - (2\tfrac{5}{8} \times 4\tfrac{1}{4}) = 16 - 11.15625 = 4.84375.$$

$$\frac{4.84375}{16} = 0.3027 \text{ or } 30.27 \text{ per cent.}$$

Reductions vary from 60 per cent downwards, depending on strength of mill, engines, etc. A convenient formula for quickly obtaining the average reduction or number of passes is

$$P = 100\left(1 - \sqrt[n]{\frac{a}{A}}\right) \text{ where}$$

P = average per cent reduction
n = number of passes
a = finished area of billet
A = original area of billet.

For example, we will assume that a 4 x 4 billet is to be reduced to a 4¼ × ¼ strip in five passes. The formula will then appear as follows:

$$P = 100\left(1 - \sqrt[5]{\frac{1.0625}{16}}\right)$$

$$= 100\ (1 - \sqrt[5]{.06640625})$$
$$= 100\ (1 - .5813375)$$
$$= 100\ (.4186625) = 41.87 \text{ per cent, where}$$

A = original area of billet = 4 x 4 = 16
a = finished area of billet = 4¼ x ¼ = 1.0625

Of course it is understood that the reductions would not probably be made exactly to the figures given, for in practice they would have to be changed somewhat, but the result given is the average reduction and from this one is enabled to form a good idea of the work to be accomplished.

Drawing the Reduction Diagram.

Generally speaking, the first pass is a "shaping" pass or "leader," and usually does not have much draft, depending on the shape to be produced. Having determined, as previously described, the area of this first pass, and the total number of passes, or the average reduction, we may proceed to draw the diagram shown in Fig. 1, from which the series of passes may be proportioned. Draw two lines meeting at A and making an agle of 95.5 degrees with each other; bisect this angle with line AX. To locate line I, for a square bar, use the following formula:

$$\frac{A}{2.2} = z, \text{ in which}$$

A = area of pass
2.2 = constant for the angle of 95.5 degrees only
z = vertical dimension of pass on line AX (Fig. 1)

If the angle of 92 degrees is used, take 2.071 as the constant.

Assuming, for example, the area of the first pass to be 26.95 square inches and substituting this value in the formula, we have

$$\frac{26.95}{2.2} = z = 3.5 \text{ inches.}$$

Measuring off from point A on the line AX (Fig. 1), this distance locates a point through which draw a horizontal line (line I in this case). The line so obtained will be the horizontal dimension of the first pass.

Having found out by the preceding methods the horizontal line for the first pass, the corresponding line for the second may be found by the following formula, which is based on the principle that the areas of similar figures vary as the squares of their corresponding dimensions:

$z^2 (1 - a) = y$, in which

z = vertical dimension on line AX (Fig. 1)

y = vertical dimension of succeeding pass

a = required per cent reduction.

For the purpose of illustration, we will assume a reduction of 20.28 per cent, and taking the dimensions of pass No. 1, as found above, the formula would appear thus:

$$3.5^2 (1 - .2028) = 3.125'' \text{ or } 3\tfrac{1}{8}''.$$

This distance laid off on line AX (Fig. 1) will locate a point through which line II (Fig. 1) will pass. In a similar way line III may be laid off from line II, and so on, until the required number of passes has been completed.

Directions for Laying Out Billet Grooves.

On the scale (Fig. 1) for 95.5 degrees, the horizontal lines numbered I to XV represent graphically the drafts of a corresponding number of grooves for Gothic and Diamond Roughing rolls laid out as previously described, and relate to an angle of 95.5 degrees only. Dotted lines for 92 degrees are drawn in, the use of which will be described later.

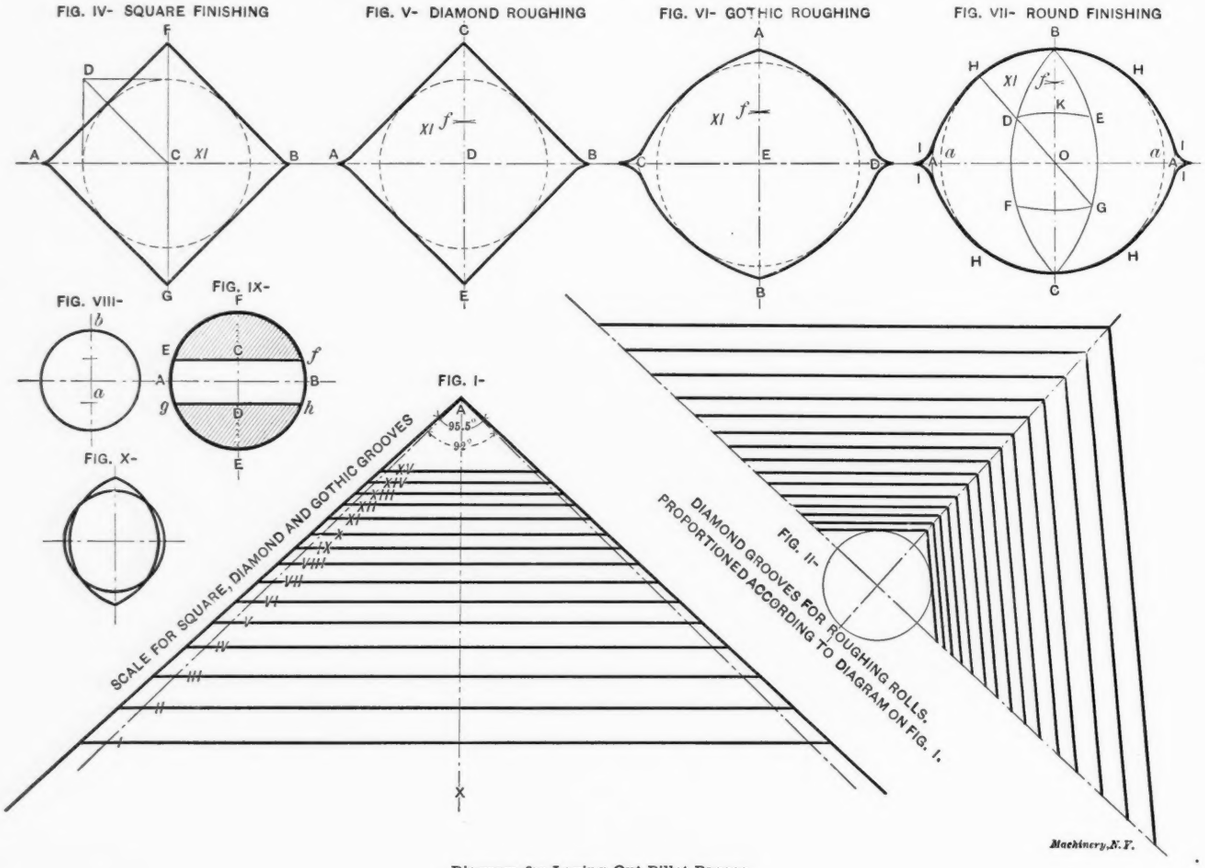


Diagram for Laying Out Billet Passes.

Diamond Grooves: Through line $A\,B$, Fig. 5, draw perpendicular line $C\,D\,E$. Refer to scale (Fig. 1, angle of 95.5 degrees) and take the vertical distance from horizontal line (XI in this case) to A, along line $A\,X$, and lay off the same from D to C and E respectively. Lay off the distance $D\,A$ and $D\,B$, each equal to one-half line $X\,I$ on scale (Fig. 1 angle of 95.5 degrees). Draw lines $A\,C$, $C\,B$, $B\,E$, and $A\,B$ and the Diamond is formed. The tailoring curves at A and B complete the figure. These are described with a radius $D\,f$ equal to ¼ the diameter of the inscribed circle.

Square Finishing Grooves: Through horizontal line $A\,B$, Fig. 4, draw perpendicular line $F\,G$. From point of intersection at C describe a circle with a diameter equal to side of square required. Draw two lines tangent to circle parallel to $A\,B$ and $F\,G$ respectively and intersecting at D and from C mark off $C\,F$ and $C\,G$ a distance equal to $C\,D$. From point A on scale (Fig. 1 angle of 92 degrees) mark off distance $C\,D$ on perpendicular line $A\,X$, and draw through the point thus located a horizontal line intersecting the sides of the 92 degree angle. (In this case the line so located corresponds to line $X\,I$.) The length of this line is the width of the groove on line $A\,B$. The tailoring curves at corners A and B are drawn with a radius of 1/10 the length of the side of the square.

Gothic Grooves: The depth $A\,B$ and width $C\,D$, Fig. 6, are formed by referring to the scale (Fig. 1 angle of 95.5 degrees, line $X\,I$ in this case). From the intersection E of the horizontal line $C\,D$ with the perpendicular $A\,B$, lay off the distances $E\,C$ and $E\,D$ each equal to one half line $X\,I$ on the horizontal line, and on the perpendicular line lay off the distance $E\,A$ and $E\,B$ each equal to the distance from A to line $X\,I$ (Fig. 1). With a radius equal to $A\,B$ draw curves $A\,D$, $D\,B$, $B\,C$ and $A\,C$. By describing the tailoring curves at C and D with a radius equal to ¼ the diameter of the inscribed circle, the figure is completed.

Round Grooves: Draw horizontal line $A\,A$, Fig. 7, and perpendicular to it draw $B\,C$. From the point of intersection describe circle of required size. From centers $a\,a$ draw arcs $B\,D\,C$ and $B\,G\,C$; with same radius from points B and C draw intersecting arcs $D\,E$ and $F\,G$. From these points of intersection, with radius $G\,H$ describe the opening curves $H\,I$. The tailoring curves at $I\,I$ are drawn with a radius $B\,f$ or one half the distance $B\,K$.

Oval Grooves: Fig. 8 is the round for which the oval is intended. Draw the round and divide the diameter into three equal parts, and with a radius $a\,b$ equal to two of these parts draw a circle, Fig. 9. The vertical diameter is divided into three equal parts. Through C and D draw lines parallel to the horizontal diameter $A\,B$. The segments $C\,E\,F\,f$ and $g\,D\,h\,E$ when put together form the oval required. See Fig. 10.

* * *

An interesting feature of the new turbine shop of the General Electric Co. is the fourteen Niles boring mills which are mostly used for facing Curtis turbine disks. All these machines are provided with water pans around the base so as to catch the drip from the tables, it being the practice to use water on the tools and run at high speed. All these boring mills have provision for facing tapers or rather of coning the sides of the disks. This is done by compound feed motion, the boring bar moving vertically while it feeds toward the center.

A METHOD OF PROCEDURE IN THE DESIGN OF HELICAL GEARS.

R. E FLANDERS.

In accordance with time-honored custom, this contribution to the art of designing helical or "spiral" gears opens with an apology. The subject is one which, from its very nature, can be approached from any one of a number of different ways, and it has been approached from so many of these possible different ways that perhaps the subject has become quite confused in the minds of many readers of technical papers. The writer does not offer the excuse of novelty in the methods presented in the following paragraphs, since some of the details which were independently worked out by him have been described by others. His reason for adding one more to the series of solutions of helical gear problems is that the method described appears to reduce the more serious of this class of problems to its most simple elements. The method of procedure will be described without proof or comment.

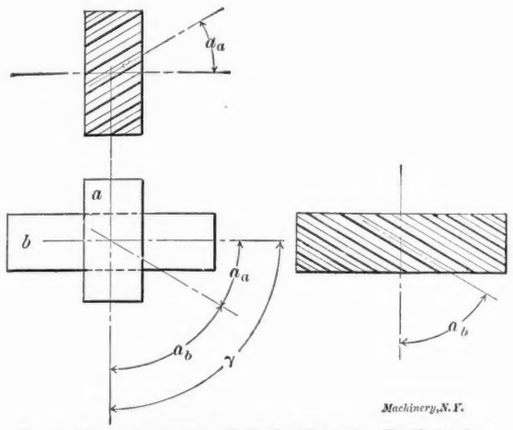


Fig. 1. Diagram showing Method of Lettering Tooth Angles.

Two terms will be used which may require some explanation. In using the expression "tooth angle," the angle made by the teeth with the axis of the gear is meant, not the angle of the tooth with the face of the gear, an unfortunate use sanctioned by some writers. Fig. 1 shows a_a as the tooth angle of gear *a* and a_b as the tooth angle of gear *b*, used in the sense in which we will use them. The angle between the shafts, γ, is 90 degrees in all the examples which will be considered in this article. The first rule to be used in the design of helical gears relates to the tooth angles.

Rule 1. *The sum of the tooth angles of a pair of mating helical gears is equal to the shaft angle.*

That is to say, in Fig. 1, angle a_a added to angle a_b equals angle γ, as is self-evident from the cut.

The second term which requires explanation is the "equivalent diameter." The quotient obtained by dividing the number of teeth in a helical gear by the diametral pitch of the cutter used gives us a very useful factor for figuring out the dimensions of helical gears, so the writer has ventured to give it this name "equivalent diameter," an abbreviation of the words "diameter of equivalent spur gear," which more accurately describe it. This quantity cannot be measured on the finished gear with a rule, being only an imaginary unit of measurement. The next rule deals with this term.

Rule 2. *The equivalent diameter of a helical gear is found by dividing the number of teeth in the gear by the diametral pitch of the cutter with which it is cut.*

For instance, in a 20-tooth gear, cut with an 8 diametral pitch cutter, the equivalent diameter will be 2½ inches. The actual diameter of the gear will vary widely from this, depending on the tooth angle.

The process of locating a railway line over a mountain range is divided into two parts: the preliminary survey or period of exploration, and the final determination of the grade line. The problem of designing a pair of helical gears resembles this engineering problem in having many possible solutions, from which it is the business of the designer to select the most feasible. For the exploration or preliminary survey the diagram shown in Fig. 2 will be found a great convenience. The materials required are a ruler with a good straight edge, and a piece of accurately ruled, or, preferably, engraved cross-section paper. If a point, *O*, be so located on the paper that *B O*, the distance to one margin line, be equal to the equivalent diameter of gear *a*, while *B' O*, the distance to the other margin line, be equal to the equivalent diameter of gear *b*, then, (when the rule is laid diagonally across the paper in any position that cuts the margin lines and passes through point *O*) *D O* will be the pitch diameter of gear *a*, *D' O* the pitch diameter of gear *b*, angle *B O D* the tooth angle of gear *a* and angle *B' O D'* the tooth angle of gear *b*. This simple diagram presents instantly to the eye all possible combinations for any given problem. It is, of course, understood that in the shape shown it can only be used for shafts making an angle of 90 degrees with each other.

The diagram as illustrated shows that a pair of helical gears having 12 and 21 teeth each, cut with a 5-pitch cutter, and having shafts at 90 degrees from each other and 5 inches apart, may have tooth angles of 36° 52′ and 53° 8′ respectively, and pitch diameters of 3 inches and 7 inches.

A correspondent has asked us to figure out the essential data for three sets of helical gears with shafts at right angles, as follows:

1st. Velocity ratio 2 to 1, center distance between shafts 2¼ inches.

2d. Velocity ratio 2 to 1, center distance between shafts 3⅜ inches.

3d. Velocity ratio 2 to 1, center distance between shafts 4 inches.

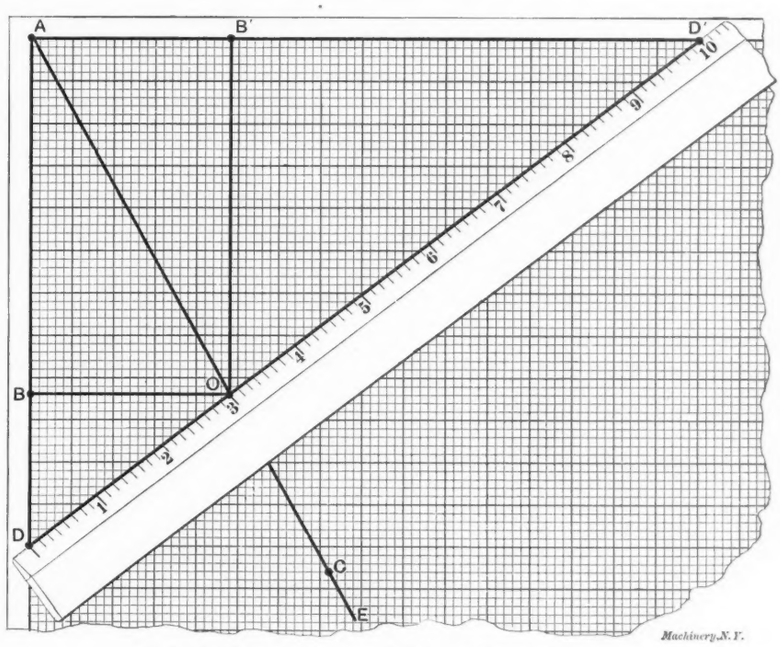


Fig. 2. Preliminary Solution with Rule and Cross-section Paper.

We will take the first of these to illustrate the method of procedure about to be described.

We have a center distance of 2¼ inches and a speed ratio between driver and driven shafts of 2 to 1. The first thing to determine is the pitch of the cutter we wish to use. The designer selects this according to his best judgment, taking into consideration the cutters on hand and the work the gearing will have to do. Suppose he decides that 12-pitch will be about right. In Fig. 2 it will be remembered that *D O* was

the pitch diameter of gear *a*, while *D' O* was the pitch diameter of gear *b*. That being the case *D O D'* is equal to twice the distance between the shafts. In the problem under consideration this will be equal to $2 \times 2\frac{1}{4}$, or $4\frac{1}{2}$ inches. Fig. 3 is a skeleton outline showing the operation of making the preliminary survey with rule and cross-section paper. *A G* and *A G'* represent the margin lines of the sheet, while *D D'* represents the graduated straight edge. By the conditions of the problem the distance between points *D* and *D'*, where the ruler crosses the margin lines, must be equal to $4\frac{1}{2}$ inches. There has next to be determined at what angle of inclination the ruler shall be placed in locating this line. To do this, we will first find our "ratio line." Select any point *C* such that *C F'* is to *C F* as 2 is to 1, which is the required ratio of our

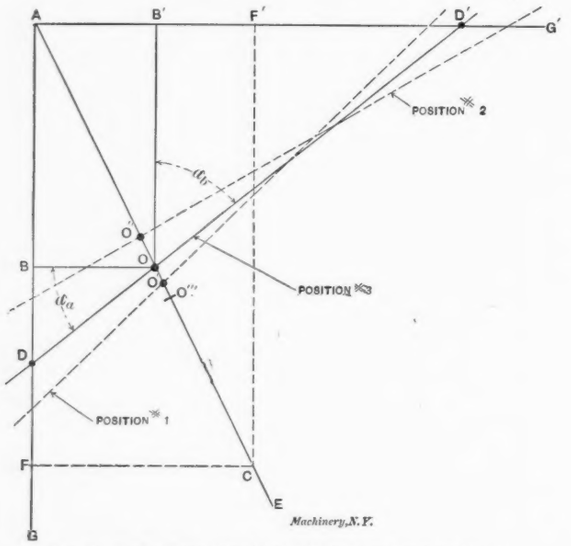


Fig. 3. Preliminary Graphical Solution for Problem No. 1.

gears. Draw through point *C*, so located, the line *A E*. Line *A E* is then the ratio line, that is, a line so drawn that the measurement taken from any point in it to the margin lines will be to each other in the same ratio as the required ratio between the driving and driven gear. Now, by shifting the ruler on the margin lines, always being careful that they cut off the required distance of $4\frac{1}{2}$ inches on the graduations, it is found that when the rule is laid as shown in position No. 1, cutting the ratio line at *O'*, the distance from the point of intersection to corner *A* is at its maximum. For the minimum value, the tooth angle is the limiting feature. For a gear of this kind, 30 degrees is, perhaps, about as small as would be advisable, so when the ruler is inclined at an angle of about 30 degrees with margin lines *A G'* and occupies position No. 2 as shown, it will cut line *A E* at *O''*, and the distance cut off from the point of intersection to corner *A* will be at its minimum value. The ruler must then be located at some intermediate position between No. 1 and No. 2.

Supposing, for example, 14 teeth in gear *a* and 28 teeth in gear *b* be tried. According to Rule 2, the equivalent diameter of gear *a* will then be $14 \div 12$, or 1.1666 inch; the equivalent diameter of *b* will be $28 \div 12$, or 2.3333 inches. Returning to the diagram to locate the point of intersection, it will be found that point *O'''* is so located that lines drawn from it to *A G* and *A G'* will be equal to 1.1666 inch and 2.3333 inches respectively, but this is beyond point *O'*, which was found to be the outermost point possible to intersect with a $4\frac{1}{2}$-inch line, *D D'*. This shows that the conditions are impossible of fulfillment.

Trying next 12 teeth and 24 teeth, respectively, for the two gears, the equivalent diameters by Rule 2 will be 1 inch and 2 inches. Point *O* is now so located that *O B* equals 1 inch and *O B'* equals 2 inches. Now, seeing this falls as required between *O'* and *O''*, stick a pin in at this point to rest the straight edge against, and shift this straight edge about until it is located in such an angular position that the margin lines of *A G* and *A G'* cut off $4\frac{1}{2}$ inches, or twice the required distance between the shafts, on the graduations. This gives the preliminary solution to the problem. Measuring as carefully as possible, *D O*, the pitch diameter of gear *a*, is found to be about 1.265 inch diameter, and *D' O*, the pitch diameter of gear *b*, about 3.235 inches. Angle *B O D*, the tooth angle of gear *a*, measures about 37° 50′. Angles *B' O D'*, the tooth angle of gear *b*, would then be 52° 10′ according to Rule 1. To determine angle *B O D* more accurately than is feasible by a graphical process, use the following rule:

Rule 3. *The tooth angle of gear a in a pair of mating helical gears, a and b, whose axes are* 90° *apart, must be so selected that the equivalent diameter of gear b plus the product of the tangent of the tooth angle of gear a by the equivalent diameter of gear a, will be equal to the product of twice the center distance by the sine of the tooth angle of gear a.*

That is to say, in this case, $O B' + (O B \times$ the tangent of angle $B O D) = D D' \times$ the sine of angle *B O D*. Perform the operations indicated, using the dimensions which were derived from the diagram, to see whether the equality expressed in this equation holds true. Substituting the numerical values:

$$2 + (1 \times 0.77661) = 4.5 \times 0.61337,$$

$$2.77661 = 2.76016,$$

a result which is evidently inaccurate.

The solution of the problem now requires that other values for angle *B O D*, slightly greater or less than 37° 50′ be tried until one is found that will bring the desired equality. It will be found finally that if the value of 38° 20′ be used as the tooth angle of gear *a*, the angle is as nearly right as one could wish. Working out rule 3 for this value:

$$2 + (1 \times 0.79070) = 4.5 \times 0.62024,$$

$$2.79070 = 2.79108.$$

Giving a difference of only 0.00038 between the two sides of the equation. The final value of the tooth angle of gear *a* is thus settled as being equal to 38° 20′. Applying Rule 1 to find the tooth angle of gear *b* we have: $90° - 38° \ 20' = 51° \ 70'$. The next rule relates to finding the pitch diameter of the gears.

Rule 4. *The pitch diameter of a helical gear equals the equivalent diameter divided by the cosine of the tooth angle; or the equivalent diameter multiplied by the secant of the tooth angle.*

If a table of secants is at hand it will be somewhat easier to use the second method suggested by the rule, since multiplying is usually easier than dividing. Using in this case, however, the table of sines and performing the operation indicated by rule 4 we have for the pitch diameter of gear *a:*

$1 \div 0.78442 = 1.2748$, or 1.275 inch, nearly;

and for the pitch diameter of gear *b:*

$2 \div 0.62024 = 3.2245$, or 3.225 inch, nearly.

To check up the calculations thus far, the pitch diameter of the two gears thus found may be added together. The sum should equal twice the center distance, thus:

$$1.275 + 3.225 = 4.500,$$

which proves the calculations for the angle.

Rule 5. *The outside diameter of a helical gear equals the pitch diameter plus the quotient of* 2 *divided by the diametral pitch of the cutter used.*

Applying this rule to gear *a:*

$1.2748 + (2 \div 12) = 1.2748 + 0.1666 = 1.4414 = 1.441$ inch, nearly.

For gear *b:*

$3.2245 + (2 \div 12) = 3.2245 + 0.1666 = 3.3911 = 3.391$ inches, nearly.

In cutting spur gears of any given pitch different shapes of cutters are used, depending upon the number of teeth in the gear to be cut. For instance, according to the Brown & Sharpe system for involute gears eight different shapes are used, for a gear from 12 teeth to a rack. The fact that a certain cutter is suited for cutting a 12-tooth spur gear is no sign that it is suitable for cutting a 12-tooth helical gear, since the fact that the teeth are cut on an angle alters their shape considerably. To find out the number of teeth for which the cutter should be selected, use the following rule:

Rule 6. *The number of teeth for which the cutter should be selected to cut a helical gear is found by dividing the number of teeth in the gear by the cube of the cosine of the tooth angle.*

Applying this rule to gear *a:*

$$12 \div 0.784^3 = 12 \div 0.4818 = 25-,$$

and for gear *b:*

$$24 \div 0.620^3 = 24 \div 0.2383 = 100 +,$$

giving, according to the Brown & Sharpe catalogue, cutter No. 5 for gear *a* and cutter No. 2 for gear *b*.

In gearing up the head of the milling machine to cut these gears it is necessary to know the lead of the helix or "spiral" required to give the tooth the proper angle. To find this, use rule 7.

Rule 7. *The lead of the helix or "spiral" of a helical gear is equal to the product of the co-tangent of the tooth angle by the pitch diameter by* 3.14.

In solving problems by this rule, as for Rule 6, it will be sufficient to use trigonometrical functions to three significant places only, this being accurate enough for all practical purposes. Solving by Rule 7 to find the lead to set up the gearing for in cutting *a:*

$1.275 \times 1.264 \times 3.14 = 5.060+$ or 5 1-16 inches, nearly;

for gear *b*:

$3.225 \times 0.790 \times 3.14 = 8.001-$ or 8 inches, nearly.

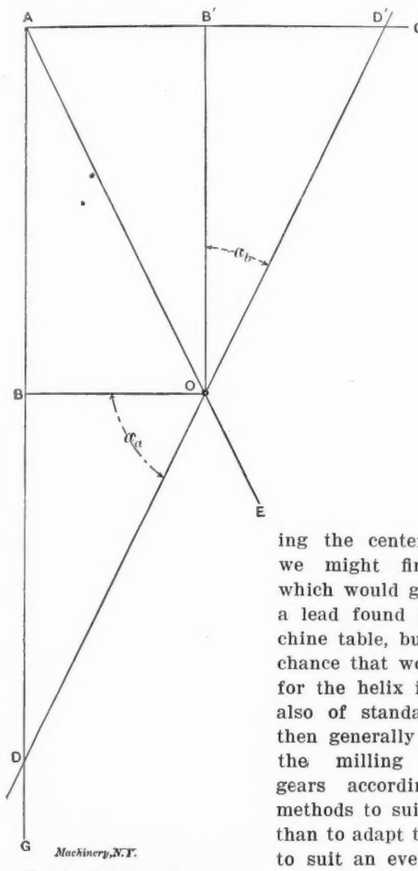


Fig. 4. Solution of Problem No. 2 for Equal Diameter.

The lead of the helix must be in general the adjustable quantity in any spiral gear calculation. If special cutters are to be made the lead of the helix may be determined arbitrarily from those given in the milling machine table; this will, however, probably necessitate a cutter of fractional pitch. On the other hand, by using stock cutters and varying the center distance slightly we might find a combination which would give us for one gear a lead found in the milling machine table, but it would only be chance that would make the lead for the helix in the mating gear also of standard length. It is then generally better to calculate the milling machine change gears according to the usual methods to suit odd leads, rather than to adapt the other conditions to suit an even lead. It will be found in practice that the lead of the helix may be varied somewhat from that calculated without seriously affecting the efficiency of the gears.

The remaining rules relating to the proportions of the teeth do not vary from those for spur gears and are here set down for the sake of completeness only.

Rule 8. *The thickness of the tooth of a standard gear at the pitch line is equal to* 1.5708 *divided by the diametral pitch of the cutter.*

For gears *a* and *b* of our problem this gives:

$$1.5708 \div 12 = 0.1309 \text{ inch.}$$

Rule 9. *The addendum of a standard gear is equal to* 1 *divided by the diametral pitch of the cutter.*

For gears *a* and *b* this will give:

$$1 \div 12 = 0.0833 \text{ inch.}$$

Rule 10. *The whole depth of the tooth of a standard gear is equal to* 2.1571 *divided by the diametral pitch of the cutter.*

This gives for gears *a* and *b*:

$$2.1571 \div 12 = .1797 \text{ inch.}$$

This completes all the calculations required to give the essential data for making the first pair of helical gears required by our correspondent. To illustrate the variety of conditions for which these problems may be solved the other cases will be worked out somewhat differently. In the case just considered no allowance was made for possible conditions which might have limited the dimensions of the gears and the problem was solved for what might be considered general good practice. Gear *a*, however, might have been too small to put on the shaft on which it was intended to go, while gear *b* might have been too large to enter the space available for it. If, as is quite likely, these gears are intended to drive the camshaft of a gas engine, the solution would probably be unsatisfactory. Case No. 2 will therefore be solved for a center distance of 3⅜ inches as required, but the two gears will be made of about equal diameter. Fig. 4 shows the preliminary graphical solution of this problem, the reference letters in all cases being the same as in Fig. 3. With a 10-pitch cutter, if this suited the judgment of the designer, 15 teeth in gear *a* and 30 teeth in gear *b* would require that the point of intersection on the ratio line *A E* be located at *O* where *B O* equals the equivalent diameter of gear *a*, which equals 1½ inch, while *B' O* equals the equivalent diameter of gear *b*, or 3 inches, both calculated in accordance with Rule 2. The required condition now is that *D O* be approximated to *D' O;* that is to say, that the pitch diameters of the two gears be about equal. After continued trial it will be found impossible to so locate *O*, using a cutter of standard diametral pitch, that *D O* and *D' O* shall be equal, and at the same time have *D D'* equal to twice the required center distance, which is $2 \times 3\frac{3}{8}$ inches or 6¾ inches. If this center distance could be varied slightly without harm *B D* could be taken as equal to *A B;* then it would be found that a line drawn from *D* so located through *O* to *D'*, though giving a somewhat shortened center distance, would make two gears of exactly the same pitch diameter.

Drawing line *D O D'*, however, as first described to suit the conditions of the problem, and measuring it for a preliminary solution the following results are obtained: The tooth angle of gear *a* = angle *B O D* = 63° 45'; and the tooth angle of gear *b* = angle *B' O D'* = 90° − 63° 45' = 26° 15', according to Rule 1. Performing the operations indicated in Rule 3 to correct these angles it is found that when the tooth angle of gear *a* is 63° 54', and that for gear *b* is 26° 6', the equation of Rule 3 becomes

$$3 + (15 \times 2.04125) = 6.75 \times .89803$$

$$6.06187 = 6.06170$$

which is near enough for all practical purposes. The other dimensions are easily obtained as before by using the remaining rules.

To still further illustrate the flexibility of the helical gear problem, the third case, for center distance of 4 inches, will be solved in a third way. It is shown in MacCord's Kinematics that to give the least amount of sliding friction between the teeth of a pair of mating helical gears, the angles should be so proportioned that, in our diagrams, line *D D'* will be approximately at right angles to ratio line *A E*. On the other hand, to give the least end thrust against the bearings, line *D D'* should make an angle of 45° with the margin lines *A G* and *A G'*, in the case of gears with axes at an angle of 90°, as are the ones being considered. The first example worked out in detail was solved in accordance with "good practice," when line *D D'* was located about one-half way between the two positions just described, thus giving in some measure the advantage of a comparative absence of sliding friction, combined with as small degree of end thrust as is practicable. To illustrate some of the peculiarities of the problem, Case 3 will now be solved to give the minimum amount of sliding friction, neglecting entirely the end thrust, which is considered to be taken up by ball thrust bearings or some equally efficient device. On trial it will be found that, with the same number of teeth in the gear and with the same pitch as in Case 2, giving in Fig. 5, *B O*, the equivalent diameter of gear *a*, a value of 1½ inch, and *B' O*, the equivalent diameter of gear *b* a value of 3 inches as in Fig. 4, line *D D'*, which is equal to twice the center distance or 8

inches, can then lie at an angle of about 90° with $A\ E$, thus meeting the condition required as to sliding friction. Thus this diagram, while relating to gears having the same pitch and number of teeth as Fig. 4 yet has an entirely different appearance, and gives different tooth angles and center distances, solving the problem as it does for the least sliding friction instead of for equal diameters of gears.

Measuring the diagram as accurately as may be the following results are obtained: Tooth angle of gear $a = B\ O\ D = 28°$; tooth angle of gear b = angle $B'\ O\ D' = 90° - 28° = 62°$. This is the preliminary solution. After accurately working it out by the process before described we have as a final solution tooth angle of gear $a = 28°\ 28'$; tooth angle of gear $b = 61°\ 32'$. From this the remaining data can be calculated.

For designers who feel themselves skillful enough to solve such problems as these graphically without reference to calculations, the diagram may be used for the final solution. The variation between the results obtained graphically and those obtained in the more accurate mathematical solution is a measure of the skill of the draftsman as a graphical mathematician. The method is simple enough to be readily copied in a note book or carried in the head. If the graphical method is to be used entirely, it will be best not to trust to the cross section paper, which may not be accurately ruled; instead skeleton diagrams like those shown in Figs. 4, 5 and 6 may be drawn. For rough solutions, however, to be afterward mathematically corrected, as in the examples considered in this article, good cross section paper is accurate enough. It permits of solving a problem without drawing a line. Point O may be located by reading the graduations; a pin inserted here may be used as a stop for the rule, from which the diameter and center distance are read directly; dividing $A\ D$ read from the paper, by $D\ D'$, read from the rule, will give the sine of the tooth angle of the gear a.

For sensible people who prefer their rules to be embodied in formulas, the appended list has been prepared, using the following reference letters, which agree in general with the nomenclature of the Brown & Sharpe gear books.

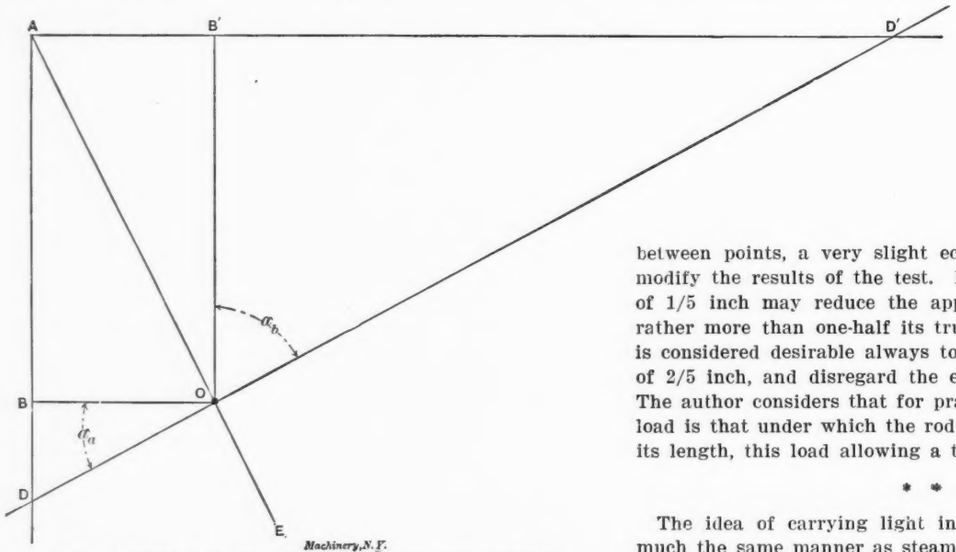


Fig. 5. Solution of Problem No. 3 for Minimum Sliding Friction.

N_a = No. of teeth in gear a.
N_b = No. of teeth in gear b.
R = Velocity ratio = $N_b \div N_a$.
P'' = Normal diametral pitch or pitch of cutter.
E = Equivalent diameter (explained above).
D = Pitch diameter.
C = Center distance.
B = Blank or outside diameter.
T = No. of teeth for which cutter is selected.
L = Lead of spiral.
γ = Angle of axes.
a = Angle of tooth with axis.
t = Thickness of tooth on pitch line.
S = Addendum.
$D'' + f$ = Whole depth of tooth.

Where subscript letters $_a$ and $_b$ are used reference is made to gears a and b, as for instance "N_a" and "N_b," where the letter N refers to the number of teeth in gear a and b, respectively of a pair of gears a and b.

$$\gamma = a_a + a_b. \tag{1}$$

$$E = \frac{N}{P''}. \tag{2}$$

$$E + (E \times \tan a_a) = 2\ C \times \sin a_a. \tag{3}$$

$$D = \frac{E}{\cos a} = E \times \text{sec. } a. \tag{4}$$

$$B = D + \frac{2}{P''} \tag{5}$$

$$T = \frac{N}{(\cos a)^3} \tag{6}$$

$$L = \cot a \times D \times \pi. \tag{7}$$

$$t = \frac{1.5708}{P''}. \tag{8}$$

$$S = \frac{1}{P''}. \tag{9}$$

$$D'' + f = \frac{2.1571}{P''}. \tag{10}$$

* * *

BUCKLING STRAIN TESTS ON ROUND RODS WITH CLAMPED ENDS.

Theoretically the clamping of round rods at both ends should increase the resistance to buckling fourfold in comparison with the resistance offered when they are mounted between points. The tests performed by Prof. B. Kirsch, however, show that with slender rods the maximum increase is only threefold, and that in moderately slender rods ($\frac{l}{D} = 100$) the increase is not more than 13 per cent, says the *Mechanical World*. Another result of the tests is that in the case of test rods, 5 to 40 inches in length, with one free end, the other clamped, the point of maximum deflection is 1¼ to 2⅛ inches nearer the clamped end than it should be theoretically. A further point of some importance is that, with test rods mounted between points, a very slight eccentricity suffices to greatly modify the results of the test. For instance, an eccentricity of 1/5 inch may reduce the apparent buckling strength by rather more than one-half its true value. For this reason it is considered desirable always to calculate on an eccentricity of 2/5 inch, and disregard the effect of clamping altogether. The author considers that for practical purposes the buckling load is that under which the rod is deflected by 1 per cent of its length, this load allowing a two-fold margin of safety.

* * *

The idea of carrying light into a room in pipes in very much the same manner as steam for heating, is one that is a decided novelty to most people, but it is substantially what the Moore Electrical Co. are doing in their system of electric lighting. Rooms lighted by the Moore system usually have a continuous tube of glass 1¾ inch diameter around the four sides near the ceiling and connected to a terminal box, in which are the bulbs containing the volatilizing substances and the electrical connections. This tube when producing light is filled with a glowing vapor of varying intensities and colors according to the service required. With this system it is possible to produce a white light having nearly the same characteristics as sunlight. It is claimed to be very economical in practice; 1.8 watts produce one candle power, or about three times as much for the same consumption of current as can be obtained from the incandescent lamps. Because of the absence of shadows it should be a lighting system worthy of attention for drafting rooms.

THE MANUFACTURE OF COLT'S AUTOMATIC ARMY PISTOL.

Six years ago the Colt's Patent Fire Arms Mfg. Co., Hartford, Conn., installed a plant for the manufacture of automatic pistols. These arms are unique in conception and design and are probably familiar to most readers of MACHINERY. A military model of this type, caliber 0.45, has recently been perfected and is illustrated in Figs. 1, 2 and 3 herewith; while the succeeding illustrations show some of the interesting machine operations upon certain parts of this pistol during its progress through the factory.

The arm can be discharged at the rate of five shots per second and is automatic except that the trigger must be pulled to fire each shot. The cartridges are automatically supplied from a detachable magazine inserted in the handle. After the pistol is charged with a filled magazine, one opening movement is made by hand, bringing the first cartridge into the chamber. On pulling the trigger the cartridge is fired, the empty shell ejected and the new cartridge loaded into the chamber. This automatic operation of the pistol is effected by the recoil of the moving parts and as a consequence the recoil is so absorbed in being utilized that it has not the usual disturbing effect.

Fig. 1. Colt Automatic Army Pistol, Slide Drawn Back.

Fig. 2. Slide and Barrel Locked. Carrying Case Serving as a Stock.

The frame of the pistol, which constitutes the handle and supports the various parts of the mechanism, is a forging

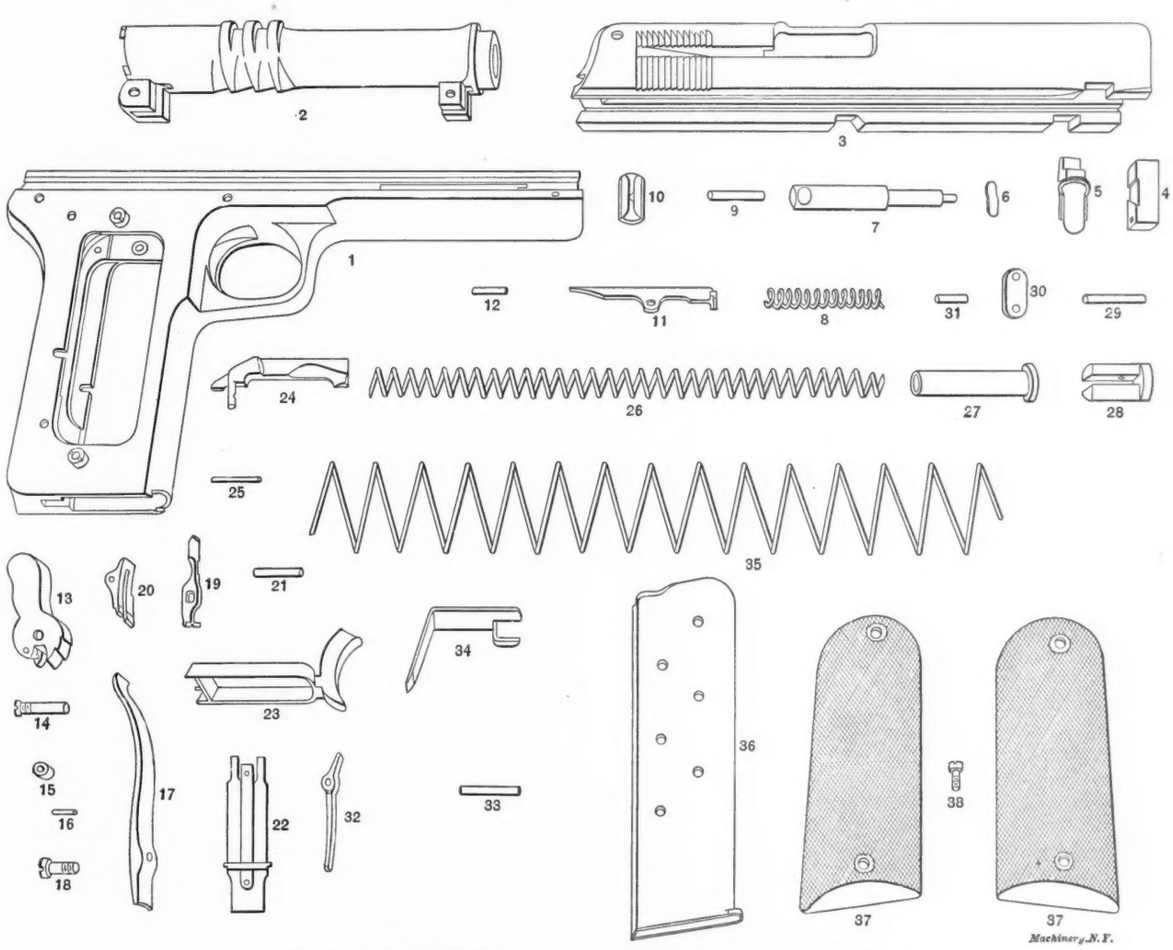


FIG. 3. COMPONENT PARTS OF AUTOMATIC COLT PISTOL, CALIBER 0.45.

1. Receiver.
2. Barrel.
3. Slide.
4. Slide Lock.
5. Slide Stop.
6. Slide Stop Spring.
7. Firing Pin.
8. Firing Pin Spring.
9. Firing Pin Lock Pin.
10. Rear Sight.
11. Shell Extractor.
12. Shell Extractor Pin.
13. Hammer.
14. Hammer Screw.
15. Hammer Roll.
16. Hammer Roll Pin.
17. Main Spring.
18. Main Spring Screw.
19. Safety.
20. Sear.
21. Sear and Safety Pin.
22. Sear, Safety and Trigger Spring.
23. Trigger.
24. Ejector.
25. Ejector Pin.
26. Retractor Spring.
27. Follower.
28. Plug (Take-down).
29. Plug and Link Pin (2).
30. Link (2).
31. Link Pin, Short (2).
32. Magazine Catch.
33. Magazine Catch Pin.
34. Magazine Follower.
35. Magazine Spring.
36. Magazine, Complete.
37. Stock, Sight and Left Hand, (per pair).
38. Stock Screws (4)
Stock Screw Studs (4).

and is known as the receiver. The barrel is supported by the receiver and is covered by a slide which moves longitudinally in grooves milled in the sides of the receiver. These three parts are clearly illustrated in Fig. 3. When it is desired to fire the pistol, the slide is drawn to the rear by hand, thereby cocking the hammer. In this position the cartridge is pressed upward into the chamber where it comes into the path of the bolt. On releasing the slide the bolt and the cartridge are carried forward, the latter into the barrel, and the former at the same time forces the barrel into its forward position, where the several parts are locked together ready for the discharge. A slight pull on the trigger now releases the hammer and fires a shot and the recoil exerted against the bolt, and overcoming the inertia of the slide, causes the latter and the barrel to recoil together. The barrel, however, stops at a certain point and the slide continues on in its movement, thereby again cocking the hammer, compressing the retractor spring and ejecting the shell. The slide now returns automatically, the cartridge is driven into the barrel and the slide and barrel are interlocked as before.

Fig. 4. Receiver and Slide Before and After Machining.

Fig. 1 shows the pistol with the slide and barrel moved backward ready to eject the empty shell. In Fig. 2 the slide and barrel are returned to their forward position. In this view the pistol is shown mounted on the end of its carrying case, which serves as a stock and makes an automatic shoulder piece capable of doing work nearly as effective as a rifle, in view of the fact that the recoil with this type of arm is very slight.

More than 500 operations are required in the manufacture of this pistol. The frame or receiver, the slide, the barrel, and other parts used in its construction are made from drop forgings of steel having a high tensile strength. To follow all these pieces through the many operations of milling, reaming, profiling, punching, etc., would make this article of too great length, and the views shown pertain to work upon the larger pieces, namely, the receiver, slide, and barrel.

From a bath or pickle for removing the light scale, the forgings go to the milling machines for the first operation of removing the rough exterior and then to the milling machines where the finishing operations are performed. After milling, the receiver goes to the profiling machines where the inside of the trigger guard, and that part in the handle cut away for the magazine, the main spring, safety, etc., are worked out to the proper depth. The metal in the handle that is cut away for the magazine which holds the cartridges is worked out by a special machine, which will be referred to later.

As the work progresses through the milling machines and profilers, the different operations are carefully gaged to insure complete interchangeability.

After milling, profiling and cutting away, to admit the magazine and limb work, the original forgings are naturally much reduced in weight, as indicated in Fig. 4, which shows a receiver and a slide both before and after the machine work has been done. The receiver for this sized pistol weighs two pounds in the forging and seven and one-half ounces when finished.

In another department the barrels are turned, bored and rifled, and in still another the manufacture of the smaller parts is carried on. After careful inspection and gaging the parts finally go to the polishing room and from there to the bluing room, then to the assembling room, and when assembled they go to the firing room where they are tested with the proof charges. Here any defects in the working of the arm, inaccuracies and imperfections are discovered. The arms are then cleaned, again inspected, oiled, boxed and placed in the stock room, ready for shipment.

The views shown in this connection tell their own story and require little description. All of the machines illustrated were designed and built at the Colt's Armory. The milling machines differ somewhat from the regular Lincoln type miller, although the spindle is adjustable vertically as in all manufacturing millers. The Colt miller is fitted with an overhanging arm such as is used with the knee-type milling machine, for steadying the cutter arbor. For heavy work this arm is supported at its outer end by a brace bolted to the frame, as in Figs. 5 and 6. This arm is made useful in other ways than by supporting the outer end of the cutter arbor, however, as in Fig. 8, where it carries an outer bearing in which a second spindle is mounted, making a double-spindle milling machine.

Another feature of these machines is a friction clutch for the belt cone, through which it drives the spindle. The clutch is made to throw out automatically by the action of a dog on the table, which can be set for any point in its travel, and is a feature that is useful when milling up to a shoulder, since it avoids milling a slight depression in the work such as always occurs when the feed is thrown out and the cutter is allowed to continue to rotate.

In Fig. 14 is a bridge milling fixture used in this instance for milling out the groove in the underside of the slide. This slot is of varying depth and its shape is controlled by the cam groove milled in the piece *B* attached to the under side of a swinging table pivoted to the support *C*, which latter is bolted to the main table of the milling machine. A pin projecting from a bracket secured to the frame of the machine acts as a guide for the cam. The pin is of a diameter to exactly fill the cam groove widthwise and as the table feeds it is raised or lowered according to the shape of the slot and the depth milled by the cutter is governed accordingly. The slide is held in fixture *A* during the milling operation.

In Fig. 16 a novel use is made of the milling machine. The pistol barrel is held in a chuck fitting in the tapered hole of the spindle and its outer end is supported by a tail spindle rotating in a bearing attached to a stationary upright arm. A formed cutter is held in the milling machine vise and as the table feeds under the rotating barrel this cutter forms the barrel to the required shape.

In Fig. 17 is a rotating milling fixture for taking a rotary milling cut at one end of the barrel, which is slightly eccentric with the main part of the barrel. The barrel is held in the spindle at *A*, at the outer end of which is the pinion and the handle *B*. This spindle has its bearings upon an auxiliary slide which can move longitudinally independently of the table feed. This slide is brought up against a stop by the hand wheel *D;* while the base to the slide, which is fastened to the carriage, is carried forward by the machine feed. The rack *C* is attached to this base and as it advances rotates the pinion and hence the barrel, which is held by the spindle *A*.

The rifling machine, Fig. 18, has four holders or chucks, one of which appears at *B*, for gripping the barrels during the rifling. The rifling tools *C* project from the carriage of the machine, which is oscillated by a crank and connecting rod driven by the large pulley at the left. The tools are given the rotary motion necessary to follow the spiral of the rifle groove by the sliding block *D* which travels back and forth in the diagonal slide as the carriage oscillates, and causes a rack meshing with pinions attached to the holders of the

rifling tools to move crosswise of the carriage and so give the necessary rotation to the tools.

The cutting points of the tools are mounted in grooves near the ends of the rods *C* and are gradually forced outward by conical plugs in the ends of these rods, which bear against the under sides of the cutters. With each forward movement of the carriage these plugs strike the stop pins *A*, which are gradually moved outward by the feed mechanism, causing the plugs to be driven inward a slight amount at each oscillation of the carriage.

There are six grooves in each barrel and in addition to the three movements mentioned above—the oscillation of the carriage, the rotation of the cutters, and the feed motion—the chucks carrying the barrels are rotated a sixth of a turn at each oscillation of the carriage. By this means the single-pointed cutters operate upon the six rifle grooves in turn.

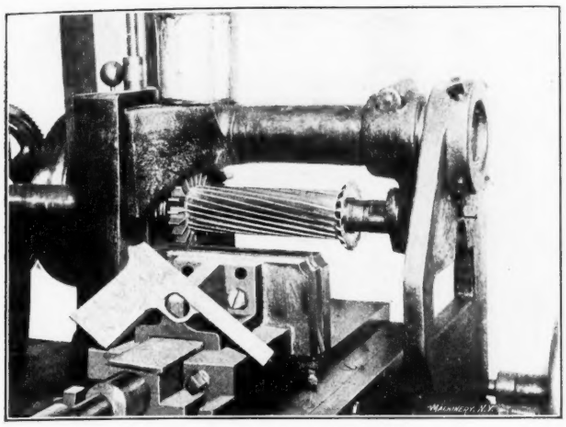


Fig. 5. Milling Top Edge of Receiver.

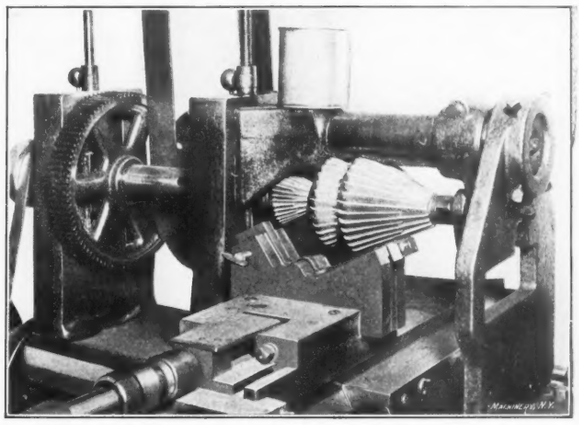


Fig. 6. Milling Bottom Edge of Receiver.

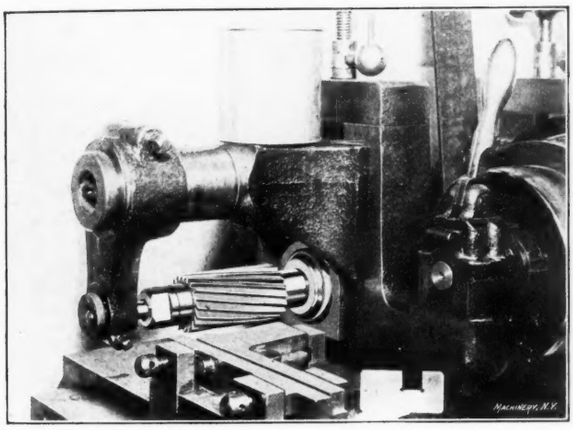


Fig. 7. Side Milling of Receiver.

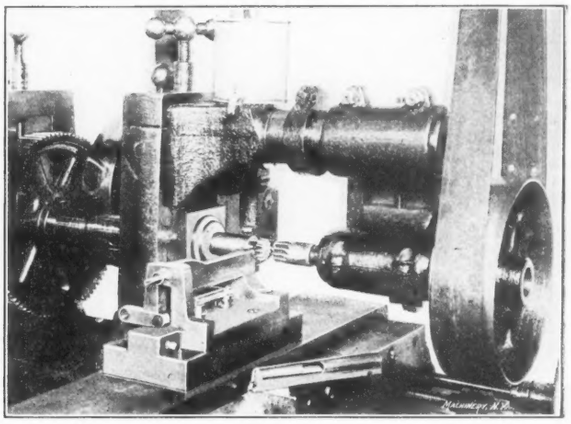


Fig. 8. Double Spindle Attachment taking Cuts on Slide.

On an upper floor of Colt's armory is a large room given up to the inspection of the finished products of the factory and in Fig. 20 is a view of one corner of this room, where the automatic pistols are inspected. These are mounted on racks, as shown, containing 20 pistols each, for convenience in handling and to avoid injury in transferring from one part of

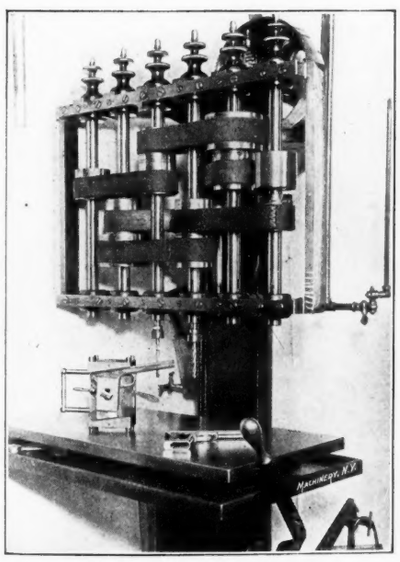


Fig 9. Six-spindle Drill Press; Drilling Receiver for Magazine.

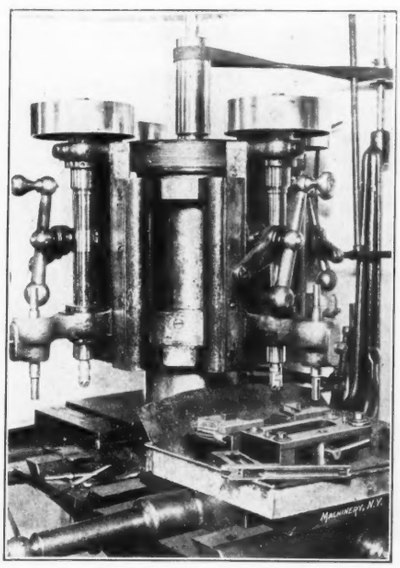


Fig. 10. Four-spindle Profiler at Work on Receiver—Spindles have Friction Drive.

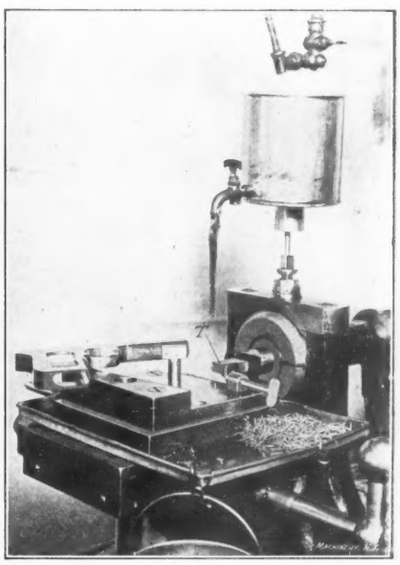


Fig. 11. Horizontal Slotter for Shaving Out Magazine Hole of Receiver.

the factory to another. Fig. 19 is from a photograph of a collection of gages, all of which are used in the inspection of the parts of an automatic pistol. Similar sets are required for pistols of other calibers.

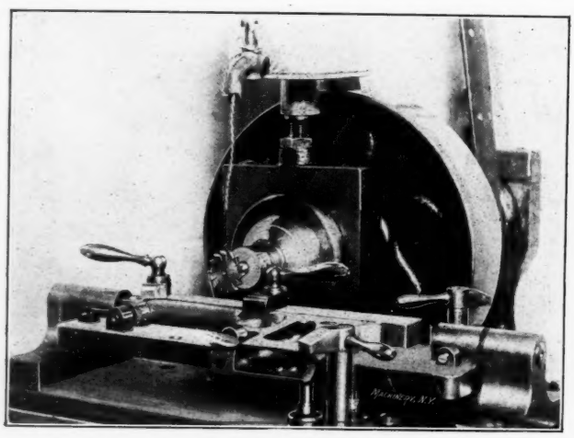


Fig. 12. Hand Milling Slot in Receiver in a Reversing Fixture.

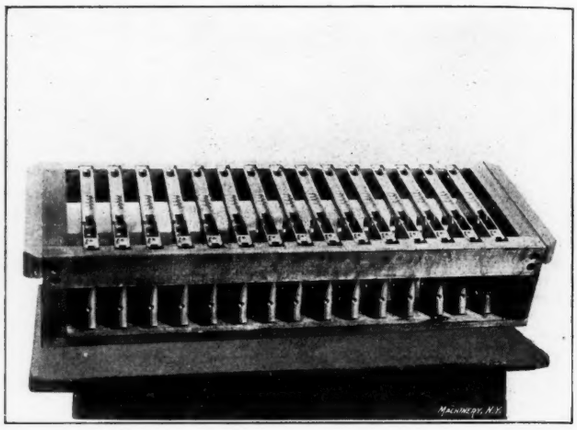


Fig. 13. Rack used for Holding Receivers during Progress of Work.

The Colt's Patent Firearms Company are the only makers of automatic pistols in this country. The features of the arm are rapidity in firing, increase in the number of shots and less recoil. Under test it has been shown to have great penetration and to be extremely accurate. Tests have been made of the army size pistol, 0.45 caliber, at the Royal Small Arms Factory in England, for the British Army. Of the several tests carried out, we will quote the following: Firing test for accuracy, distance 25 yards, 21 shots; 7 shots within 3-inch circle. Wet and dry sand test, 21 shots fired without cleaning. Penetration test, distance 30 yards, pentrated 11 one-inch pine boards placed at one inch apart. Velocity test, 7 shots gave 827.5 feet per second. A long series of accuracy tests were conducted subsequent to the accuracy test mentioned above, with the following results: Distance, 25 yards; 8 shots fired in a space of 3 inches, 8 shots fired rapidly in 4¾ inches, 14 shots fired rapidly in 5 inches, 7 shots in a space of 4 inches. At a distance of 30 yards: 8 shots in a 3¼-inch circle, 14 shots fired rapidly within 5 inches, 8 shots within 3¾ inches, 8 shots within 3⅛ inches.

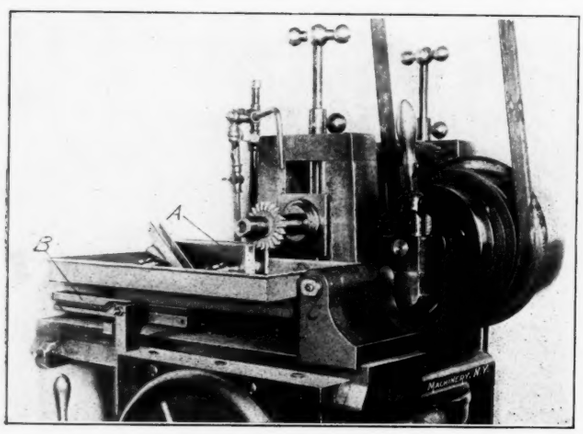


Fig. 14. Bridge Milling Slides.

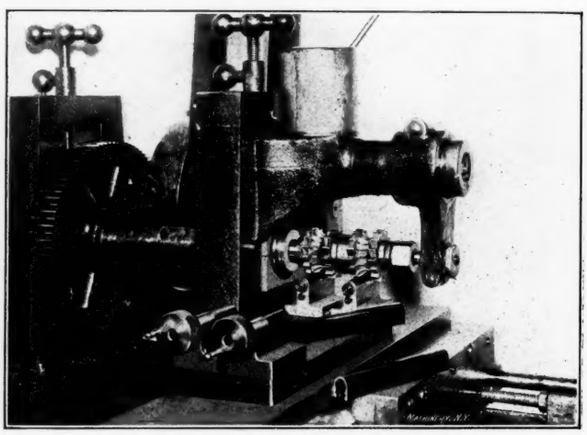


Fig. 15. Double Fixture used for Slides.

The comments made upon the action of the mechanism and the practical operation of the arm were highly commendatory of the work of this American firm. It is stated that the ejection of the shell is upward and to the right and does not inconvenience the firer or the man on his right. No tests have as yet been made by the United States Army.

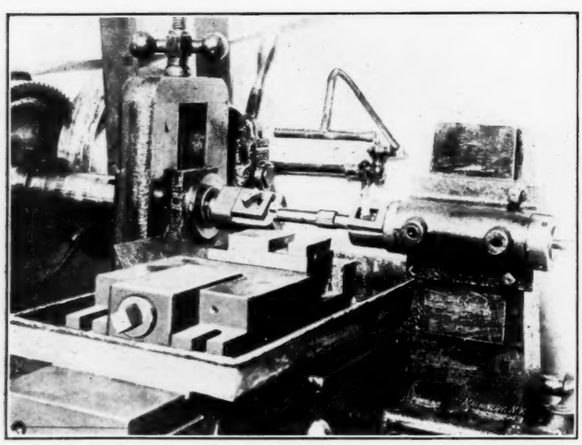


Fig. 16. Form Turning on the Milling Machine. The Barrel Rotates Tail Spindle; Form Cutter Attached to Table.

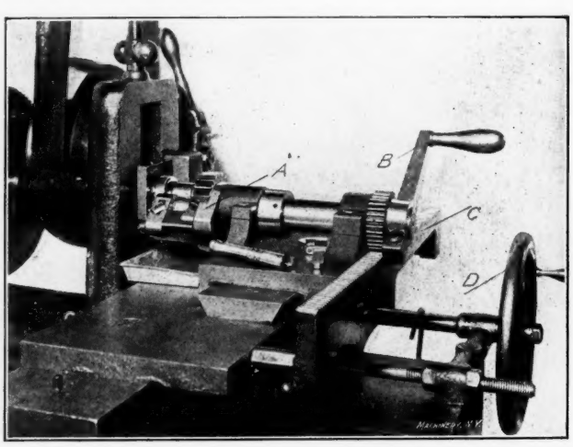


Fig. 17. Rotary Milling on the Barrel. A Special Fixture Rotates the Barrel while Cut is Taken.

SHOULD A MECHANIC SIT WHILE WORKING?

A contributor has written us a communication on the subject "Should a Mechanic Sit While Working?" in which is discussed, with some warmth, the relative merits of making

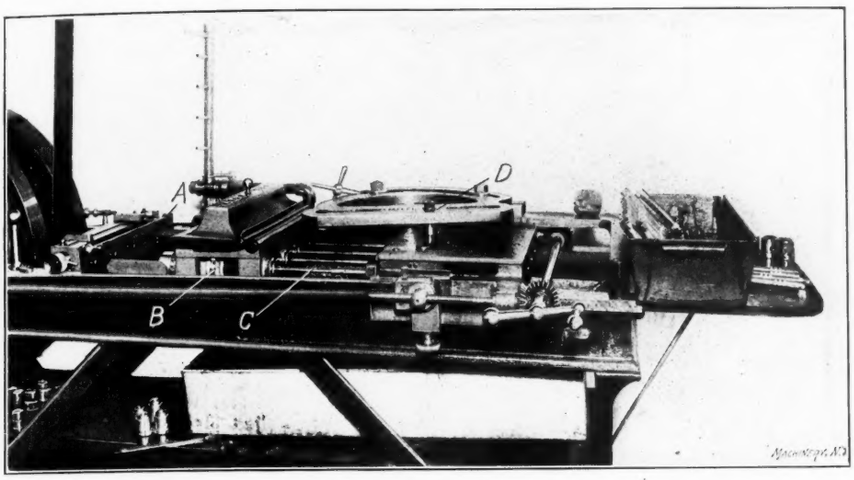


Fig. 18. Rifling Machine

men stand or allowing them to sit when the nature of their work permits them to do so. It seems to us this question is one that is easily answered and any superintendent who is not competent to decide the matter in his own works is hardly the man to fill his position. A test that may be safely used for determining whether a man shall sit or stand at his work is to ascertain what his position would be if he were doing the same work on the piecework basis. If then he always stands, it is pretty safe to say that this position is the most advantageous for him, but, if on the other hand he finds that he can produce more work and do it easier by sitting, by all means let him sit. The old idea, and one still largely prevalent among many masters, is that workmen should be made about as uncomfortable as possible, seeming to think that in this way they are getting more for the wages paid. There was never a more mistaken idea, and the contrary policy, of course, is the one that wins out in the end. If a workman has a job at which he cannot move about to any great extent it certainly is very tiresome to always stand; he will become more wearied than if he were constantly on his feet and moving about during the same length of time.

To say that the proper handling of men is a great problem is only reiterating a well-known fact, but it is one we must never forget. There are many men, no doubt, who do not appreciate considerate treatment, and if they have a chance they will often reward kindness and fair treatment with contempt, and misuse of privileges. Such actions are hard to excuse and the tendency is to meet them with some reprisal on the shop as a whole. But we believe that rather than make a whole shopful of men suffer for the dirty work of a few it is better to discharge those few men and rely upon the good sense of the others to make the best use of the privileges allowed. If a man does not and will not appreciate the opportunity of directing his own work to the best mutual advantage, let him go elsewhere where such privileges are denied and work with those fellows who must be driven by the lash, as it were. So, in handling the question of whether a man shall stand or sit at his work, the conditions of that work should always govern; and educate the men so that these conditions rather than the mere pres-

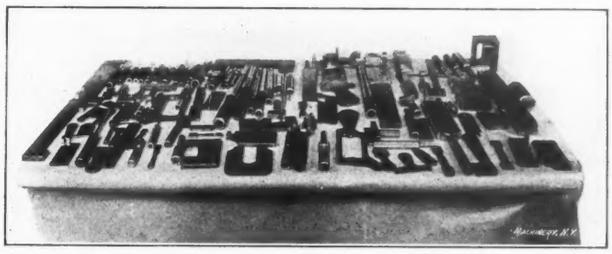


Fig. 19. Collection of Gages used in Inspection of Pistol Parts.

ence of the foreman will govern them—let him be a director and not a "slave-driver."

* * *

Don't take a heavy stock cut off with a planer and then a finishing cut without letting up on the work and allowing all of the strain to come out, and don't take a finishing cut on a broad surface of cast iron without first filing the scale on the front end all away as far down as the tool goes.

Fig. 20 Corner of Inspector's Department.

SOLID LATHE ARBORS.

H. D.

Convenient formulas and tables will be found below, giving well-proportioned dimensions for arbors to be used in a lathe.

A = total length.
B = length of actual arbor.
C = length of end, turned down for dog.
D = diameter of arbor.
E = diameter of end, turned down for dog.
F = distance of size from small end.

For arbors from ¼ to 2 inches diameter, use the following formulas:

$$A = 4D + 3.$$
$$B = 3D + 1\tfrac{5}{8}.$$
$$C = \frac{D}{2} + \frac{11}{16}.$$
$$E = \tfrac{7}{8} D.$$
$$F = \frac{D}{4} D + \frac{7}{16}.$$

For arbors from 2 1-16 to 4 inches diameter use the following formulas:

$$A = 3D + 5.$$
$$B = 2D + 3\tfrac{5}{8}.$$
$$C = \frac{D}{2} + \frac{11}{16}.$$
$$E = \tfrac{7}{8} D.$$
$$F = \frac{D}{2} + \frac{15}{16}.$$

In the table some dimensions that would figure out in 64ths have been given in 32ds when such approximation has been considered preferable.

Dimensions for flats for dog, and for counterbores and centers in ends of arbors ought to be as per formulas and table below.

G = diameter of drill.
H = depth of drilled hole.
I = diameter of center.
K = diameter of counterbore.
L = depth of counterbore.
M = width of flat for dog.

For arbors from ¼ to 2 inches diameter use the following formulas:

$$G = \frac{D}{16} + \frac{1}{32}. \qquad K = \frac{D}{4} + \frac{1}{8}.$$
$$H = \frac{D}{2}. \qquad L = \frac{1}{32}.$$
$$I = \frac{D}{8} + \frac{1}{8}. \qquad M = \frac{5}{16} D.$$

For arbors from 2 1-16 to 4 inches diameter use the following formulas:

$$G = \frac{D}{16} + \frac{1}{32}. \qquad K = \frac{D}{4} + \frac{3}{16}.$$
$$H = \frac{D}{8} + \frac{3}{4}. \qquad L = \frac{1}{16}.$$
$$I = \frac{D}{8} + \frac{1}{4}. \qquad M = \frac{5}{16} D.$$

In the following table the diameter of the drill has been given according to Stub's steel wire gage. For arbors with very heavy duty the centers may be made somewhat larger than the dimensions in the table.

The dimensions for centers and flats have been carried out in table only for every one-eighth inch, as the differences in these dimensions are very slight.

It will be noticed that a dimension F has been given for the distance of size D from the small end of the actual arbor. This implies, as every one familiar with arbors knows, that the arbor is tapered. This is, of course, for allowing the arbor to find its way straight into the piece it is intended to support, and to allow for possible variations in the diameters of the holes. The taper should be made very slight, about 0.005 inch to the foot.

As far as the hardening of arbors is concerned, the practice of late has been to harden them all over. That this practice has been adopted at a rather recent date has probably been due

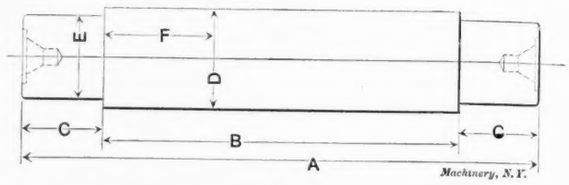


TABLE I. DIMENSIONS OF SOLID LATHE ARBORS.

D	A	B	C	E	F
¼	4	2 3/8	1 3/32	7/32	5/8
5/16	4 1/4	2 7/16	1 7/32	9/32	43/64
3/8	4 1/2	2 3/4	1 7/32	11/32	23/32
7/16	4 3/4	2 15/16	1 9/32	3/8	49/64
1/2	5	3 1/8	1 5/16	7/16	13/16
9/16	5 1/4	3 5/16	1 31/32	1/2	55/64
5/8	5 1/2	3 1/2	1	9/16	29/32
11/16	5 3/4	3 11/16	1 1/32	5/8	61/64
3/4	6	3 7/8	1 1/16	11/16	1
13/16	6 1/4	4 1/16	1 3/32	3/4	1 3/64
7/8	6 1/2	4 1/4	1 1/8	13/16	1 3/32
15/16	6 3/4	4 7/16	1 5/32	7/8	1 9/64
1	7	4 5/8	1 1/16	15/16	1 3/16
1 1/16	7 1/4	4 13/16	1 7/32	1	1 5/64
1 1/8	7 1/2	5	1 1/4	1 1/32	1 3/32
1 3/16	7 3/4	5 3/16	1 9/32	1 1/16	1 21/64
1 1/4	8	5 3/8	1 5/16	1 3/32	1 3/8
1 5/16	8 1/4	5 9/16	1 11/32	1 1/8	1 27/64
1 3/8	8 1/2	5 3/4	1 3/8	1 5/32	1 15/32
1 7/16	8 3/4	5 15/16	1 13/32	1 3/16	1 33/64
1 1/2	9	6 1/8	1 7/16	1 7/32	1 9/16
1 9/16	9 1/4	6 5/16	1 15/32	1 1/4	1 39/64
1 5/8	9 1/2	6 1/2	1 1/2	1 9/32	1 19/32
1 11/16	9 3/4	6 11/16	1 17/32	1 5/16	1 45/64
1 3/4	10	6 7/8	1 9/16	1 11/32	1 3/4
1 13/16	10 1/4	7 1/16	1 19/32	1 3/8	1 51/64
1 7/8	10 1/2	7 1/4	1 5/8	1 13/32	1 27/32
1 15/16	10 3/4	7 7/16	1 21/32	1 7/16	1 57/64
2	11	7 5/8	1 11/16	1 15/32	1 29/32
2 1/16	11 3/16	7 13/16	1 23/32	1 1/2	1 59/64
2 1/8	11 3/8	8	1 3/4	1 17/32	2
2 3/16	11 9/16	8 3/16	1 25/32	1 9/16	2 1/32
2 1/4	11 3/4	8 3/8	1 13/16	1 19/32	2 1/16
2 5/16	11 15/16	8 1/2	1 27/32	1 5/8	2 3/32
2 3/8	12 1/8	8 11/16	1 7/8	1 21/32	2 1/8
2 7/16	12 5/16	8 7/8	1 29/32	1 11/16	2 5/32
2 1/2	12 1/2	8 15/16	1 15/16	1 23/32	2 3/16
2 9/16	12 11/16	9 1/16	1 31/32	1 3/4	2 7/32
2 5/8	12 7/8	9 1/4	2	1 25/32	2 1/4
2 11/16	13 1/16	9 7/16	2 1/32	1 13/16	2 9/32
2 3/4	13 1/4	9 5/8	2 1/16	1 27/32	2 5/16
2 13/16	13 7/16	9 13/16	2 3/32	1 7/8	2 11/32
2 7/8	13 5/8	10	2 1/8	1 29/32	2 3/8
2 15/16	13 13/16	10 3/16	2 5/32	1 15/16	2 13/32
3	14	10 3/8	2 3/16	1 31/32	2 7/16
3 1/16	14 3/16	10 9/16	2 7/32	2	2 15/32
3 1/8	14 3/8	10 3/4	2 1/4	2 1/32	2 1/2
3 3/16	14 9/16	10 15/16	2 9/32	2 1/16	2 17/32
3 1/4	14 3/4	11 1/8	2 5/16	2 3/32	2 9/16
3 5/16	14 15/16	11 5/16	2 11/32	2 1/8	2 19/32
3 3/8	15 1/8	11 1/2	2 3/8	2 5/32	2 5/8
3 7/16	15 5/16	11 11/16	2 13/32	2 3/16	2 21/32
3 1/2	15 1/2	11 7/8	2 7/16	2 7/32	2 11/16
3 9/16	15 11/16	12 1/16	2 15/32	2 1/4	2 23/32
3 5/8	15 7/8	12 1/4	2 1/2	2 9/32	2 3/4
3 11/16	16 1/16	12 7/16	2 17/32	2 5/16	2 25/32
3 3/4	16 1/4	12 5/8	2 9/16	2 11/32	2 13/16
3 13/16	16 7/16	12 13/16	2 19/32	2 3/8	2 27/32
3 7/8	16 5/8	13	2 5/8	2 13/32	2 7/8
3 15/16	16 13/16	13 3/16	2 21/32	2 7/16	2 29/32
4	17	13 3/8	2 11/16	2 15/32	2 15/16

to the increased demand for tools of strength and durability created by the high-speed steels and changed commercial conditions. But it can by no means be said that an arbor hardened all over will in the long run produce as *accurate* work as would an arbor hardened only at the ends, the actual arbor being left soft. The reason for this is easily explained and understood. When hardening the arbor all over severe internal stresses will occur, and after having been used for some

time, and hammered upon more or less when driving on and off pieces, these internal stresses will cause the arbor to spring and get out of true very easily. This will not occur with a soft arbor, hardened only at the ends, as no internal stresses of any amount have to be considered. To keep a soft arbor in good condition, and to keep it true, it is only necessary to

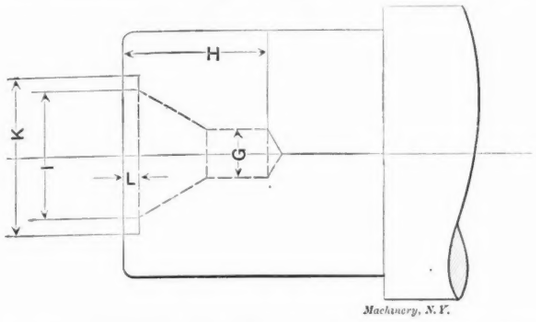


TABLE II. DIMENSIONS FOR CENTERS, FLATS, DRILLS, ETC. FOR SOLID LATHE ARBORS.

D	G	H	I	K	L	M
$\frac{1}{4}$	.045	$\frac{1}{8}$	$\frac{5}{32}$	$\frac{3}{16}$	$\frac{1}{32}$	$\frac{5}{64}$
$\frac{5}{16}$	.055	$\frac{3}{16}$	$\frac{11}{64}$	$\frac{7}{32}$	$\frac{1}{32}$	$\frac{1}{4}$
$\frac{3}{8}$	.063	$\frac{1}{4}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{1}{32}$	$\frac{5}{32}$
$\frac{7}{16}$	.072	$\frac{5}{16}$	$\frac{13}{64}$	$\frac{9}{32}$	$\frac{1}{32}$	$\frac{3}{16}$
$\frac{1}{2}$	.079	$\frac{3}{8}$	$\frac{7}{32}$	$\frac{5}{16}$	$\frac{1}{32}$	$\frac{15}{64}$
$\frac{9}{16}$	.088	$\frac{7}{16}$	$\frac{15}{64}$	$\frac{11}{32}$	$\frac{1}{32}$	$\frac{9}{32}$
1	.095	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{32}$	$\frac{5}{16}$
$1\frac{1}{8}$	.103	$\frac{9}{16}$	$\frac{17}{64}$	$\frac{13}{32}$	$\frac{1}{32}$	$\frac{11}{32}$
$1\frac{1}{4}$	.110	$\frac{5}{8}$	$\frac{9}{32}$	$\frac{7}{16}$	$\frac{1}{32}$	$\frac{25}{64}$
$1\frac{3}{8}$	.120	$\frac{11}{16}$	$\frac{19}{64}$	$\frac{15}{32}$	$\frac{1}{32}$	$\frac{7}{16}$
$1\frac{1}{2}$	.127	$\frac{3}{4}$	$\frac{5}{16}$	$\frac{1}{2}$	$\frac{1}{32}$	$\frac{15}{32}$
$1\frac{5}{8}$	.134	$\frac{13}{16}$	$\frac{21}{64}$	$\frac{17}{32}$	$\frac{1}{32}$	$\frac{1}{2}$
$1\frac{3}{4}$	.143	$\frac{7}{8}$	$\frac{11}{32}$	$\frac{9}{16}$	$\frac{1}{32}$	$\frac{35}{64}$
$1\frac{7}{8}$	.151	$\frac{15}{16}$	$\frac{23}{64}$	$\frac{19}{32}$	$\frac{1}{32}$	$\frac{19}{32}$
2	.157	1	$\frac{3}{8}$	$\frac{5}{8}$	$\frac{1}{32}$	$\frac{5}{8}$
$2\frac{1}{8}$	.164	$1\frac{1}{64}$	$\frac{33}{128}$	$\frac{21}{32}$	$\frac{1}{16}$	$\frac{21}{32}$
$2\frac{1}{4}$	.172	$1\frac{1}{32}$	$\frac{17}{64}$	$\frac{11}{16}$	$\frac{1}{16}$	$\frac{45}{64}$
$2\frac{3}{8}$	.180	$1\frac{3}{64}$	$\frac{35}{128}$	$\frac{23}{32}$	$\frac{1}{16}$	$\frac{3}{4}$
$2\frac{1}{2}$	.188	$1\frac{1}{16}$	$\frac{9}{32}$	$\frac{25}{32}$	$\frac{1}{16}$	$\frac{25}{32}$
$2\frac{5}{8}$	.197	$1\frac{5}{64}$	$\frac{37}{128}$	$\frac{13}{16}$	$\frac{1}{16}$	$\frac{13}{16}$
$2\frac{3}{4}$	.204	$1\frac{3}{32}$	$\frac{19}{64}$	$\frac{27}{32}$	$\frac{1}{16}$	$\frac{55}{64}$
$2\frac{7}{8}$	.212	$1\frac{7}{64}$	$\frac{39}{128}$	$\frac{7}{8}$	$\frac{1}{16}$	$\frac{29}{32}$
3	.219	$1\frac{1}{8}$	$\frac{5}{32}$	$\frac{29}{32}$	$\frac{1}{16}$	$\frac{15}{16}$
$3\frac{1}{8}$	.227	$1\frac{9}{64}$	$\frac{41}{128}$	$\frac{15}{16}$	$\frac{1}{16}$	$\frac{31}{32}$
$3\frac{1}{4}$	.234	$1\frac{5}{32}$	$\frac{21}{64}$	1	$\frac{1}{16}$	$1\frac{1}{64}$
$3\frac{3}{8}$	.242	$1\frac{11}{64}$	$\frac{43}{128}$	$1\frac{1}{32}$	$\frac{1}{16}$	$1\frac{1}{16}$
$3\frac{1}{2}$	.250	$1\frac{3}{16}$	$\frac{11}{32}$	$1\frac{1}{16}$	$\frac{1}{16}$	$1\frac{3}{32}$
$3\frac{5}{8}$	.257	$1\frac{13}{64}$	$\frac{45}{128}$	$1\frac{3}{32}$	$\frac{1}{16}$	$1\frac{1}{8}$
$3\frac{3}{4}$	.266	$1\frac{7}{32}$	$\frac{23}{64}$	$1\frac{1}{8}$	$\frac{1}{16}$	$1\frac{11}{64}$
$3\frac{7}{8}$	.272	$1\frac{15}{64}$	$\frac{47}{128}$	$1\frac{5}{32}$	$\frac{1}{16}$	$1\frac{7}{32}$
4	.281	$1\frac{1}{4}$	$\frac{3}{8}$	$1\frac{3}{16}$	$\frac{1}{16}$	$1\frac{1}{4}$

use it with care. When really accurate work is desired, arbors hardened at the ends only should therefore always be used.

[Where hardened arbors are desirable they should be "seasoned" before finish grinding, the same as plug gages, etc. This process relieves the internal stresses and reduces the probability of springing in use.—EDITOR.]

* * *

RULES FOR DRAFTSMEN.

In a paper, "The Hand Writing of Mechanics," *i. e.*, mechanical drawing—read by Mr. Eugene Ranson before the Ohio Society of Electrical Mechanics and Steam Engineers, the author spoke of the ease with which a difficult mechanical idea can be conveyed to another by means of a few lines, and then referred to the want of standard practice in mechanical delineation. He gave a number of rules which in his opinion should be observed by mechanical draftsmen generally, one of which is as follows:

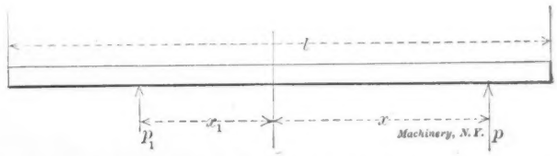
"Do not obscure a drawing by a lot of notes. Literature looks cheap on a drawing. The drawing should tell its own story without remarks, and the workman has a right to expect it. Besides, notes are a prolific source of error, as they tend to confuse or escape notice entirely."

There are many draftsmen—good ones, too—who will strongly disagree with Mr. Ranson over this rule. He tells them not to obscure a drawing by a lot of notes, and, of course, nothing *should* be done to any drawing to obscure it, but why should a few notes, properly made, on a drawing tend to confuse it. On the contrary, such notes may save much valuable time, if not costly mistakes. Again, a simple note may sometimes save making another view, which would contain nothing not shown on the others save some minor detail. Mr. Ranson evidently believes that a mechanical drawing should be a drawing and nothing more, but unfortunately (or fortunately) all men are not trained alike and do not think alike. What is plain to one is obscure to another. A drawing is not the end, but only a means to an end, being an illustrated direction for performing certain work. If a draftsman has reason to believe that a simple drawing is liable to be misunderstood, he should by all means make such notations on it that will prevent the mechanic going astray. The very fact that mechanical drawing is the "hand writing of mechanics" does not preclude the use of other hand writing if the first does not seem to fully fill the bill. Where a shop has a system of operation sheets giving the details of work of each piece the use of notes on the general drawings is unnecessary and should not be allowed, but this refinement of practice is one not found in the majority of shops.

* * *

THE LAW OF FRICTION.

A simple and beautiful experiment, illustrating the truth of the law that friction is proportional to the normal pressure between surfaces having a constant mutual coefficient, is described by a correspondent of *Engineering*. A meter stick, yard stick, or any straight rod, having a uniform section, completes the apparatus required. If such a stick be supported as a beam upon an outstretched finger of each hand, and the fingers be then moved inward toward the center of the rod, it will be observed that they invariably meet exactly at the center. A graduated rod facilitates the experiment by showing the successive stages of the movement, for it will be noticed that one or the other finger will make a temporary



advance, but will then be overtaken by that farthest from the medial line of the rod. If l be the length of the rod, w the weight per unit of length, and x and x_1 be the distances of the fingers from the medial line at a given instant, then the moment equation about one end of the rod will be

$$\frac{w l^2}{2} = \left(\frac{l}{2} - x_1\right) p_1 + \left(\frac{l}{2} + x\right) p,$$

p_1 and p being the reactions at the supports, or $p_1 + p = w\,l$.

Hence, it follows that

$$p = w\,l \left(\frac{x_1}{x + x_1}\right)$$

$$p_1 = w\,l \left(\frac{x}{x + x_1}\right)$$

By multiplying each expression for the reactions by the coefficient of friction, the resistance to sliding at the supports is found; and it is clear that this is inversely as the distance of the support (finger) from the medial line of the stick. Sliding therefore takes place over that finger which is the more distant from the center upon the application of the force, and any inequality of distance is thus wiped out. Unless, therefore, the friction was directly proportional to the pressure, the resulting meeting of the fingers on the medial line of the stick would only be a chance occurrence.

* * *

Moisture in the cylinder of a gas engine is sometimes the cause of its refusal to start. This is only one of many things that make the gas engine considerable of a mystery to the uninitiated, and even the old-timer occasionally runs up against a proposition that gives him considerable puzzlement.

THE MANUFACTURE OF BELTING AT THE SCHIEREN FACTORY.

Although leather belting is one of the most common factory supplies, it is probable that few, even of those who operate belt-driven machinery every day of their lives, are familiar with the different steps of manufacture required to convert the hide into the finished product. At the plant of Charles A. Schieren & Co., New York, there is an especially favorable opportunity for observing the several processes, since this company occupy a new and modern building, which they have recently erected for their own use and for the use of other firms in the leather business, who rent such lofts or offices as are not required by the owners. It is a ten-story fireproof building, with all steel work protected by non-conducting covering. Power is furnished by an independent steam and electric plant, and the elevator service, facilities for shipping, the lighting, etc., are in accord with the most modern ideas for city buildings.

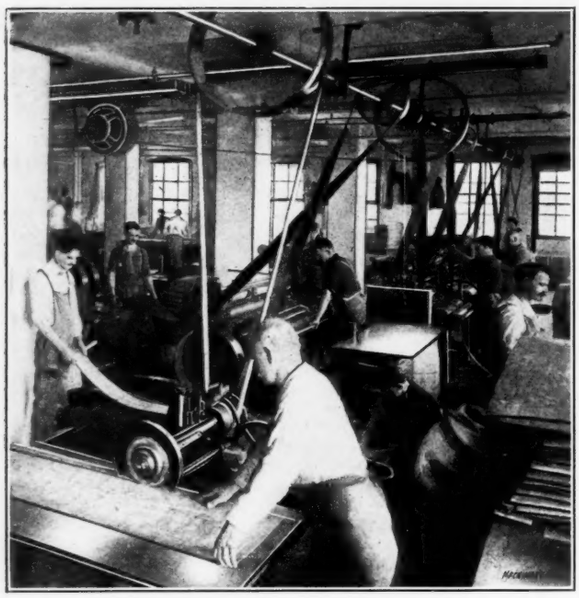


Fig. 1. The Cutting and Scarfing Machines.

The location of the building, on Ferry street, is in the section known as the "swamp," directly east of Post Office Square. In the early days of New York, when, as in other small towns, the inhabitants depended to a large extent upon products manufactured within the town limits, there were tanneries in the "swamp" district; and although these have long since ceased to exist, the leather business is still centered in this section and many of the wholesale leather houses and plants for the manufacture of leather goods are located there.

For the manufacture of high-grade leather belting only the butt portions of the hide are suitable, and this is the only part used for belts by this company. The flanks, shoulders and necks are sold for shoe leather. The butts are received in the basement, where the hides are cleaned and softened by washing in a large rotating tank containing water. They are then submitted to a scouring process, during which they are laid, one at a time, flesh side up, on a table where blunt reciprocating scrapers pass over the hide and squeeze out the water and dirt. The hide is then laid over a beam, the flesh side scraped by hand, and the pieces of soft leather not suitable for belting are removed. These pieces are not wasted, however, for they are sold and used for making a compressed leather that is employed for a variety of purposes, among them the heels of shoes. The final steps in the preparation of the hide are its treatment with oil on the grain side and tallow on the flesh side, to preserve the leather and make it pliable, and at last stretching and drying.

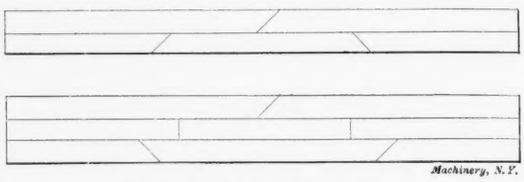


Fig. 3 Method of Making Joints.

The butts are carried from the basement to the sixth floor where the manufacturing begins. They are first put through cutting and scarfing machines, a view of which appears in Fig. 1. The cutting machines have a rotary knife like a circular saw without teeth, but the knife and its spindle are above the cutting table instead of below it. The leather is run under the knife, the width of the strips being gaged by guides and the strips then go to the scarfing machines, where the ends are shaved off on a bevel about three inches long for the joints. Before gluing the joints, however, the scarfed ends are finished to a fine edge by hand shaving, squared with the sides and matched for length. The scarfs are also scraped to remove any irregularities produced by the cutters of the scarfing machines.

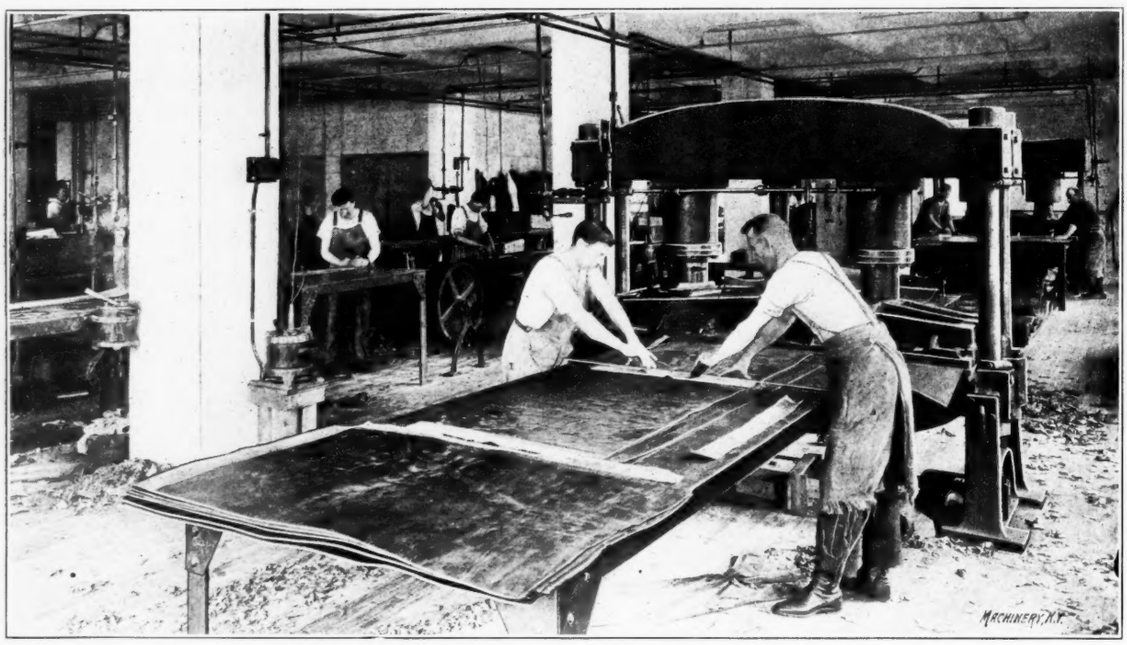


Fig. 2. Special Hydraulic Press for Building up and Cementing Belts.

The belts are built up and cemented on tables of Watson-

Stillman hydraulic presses made especially for this work. Fig. 2 shows one of the larger presses which has a table 8 feet wide and is designed for the largest belts used in textile mills or in dynamo driving. To insure a neat joint and a straight belt, great care is taken to bring the sides of the strips of belt to be glued in a straight line; and when this is done and the scarfs are bought to the correct position, a steel straightedge is placed on top of the lower belt, and

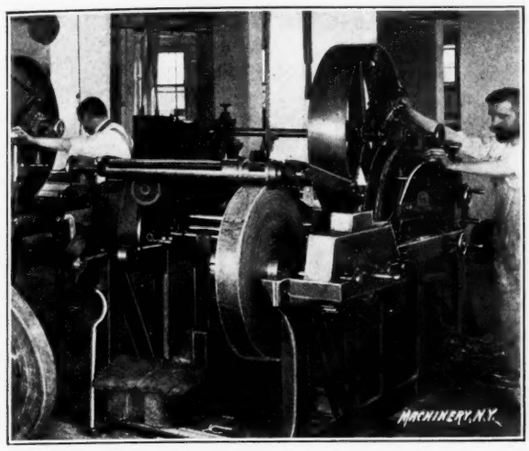


Fig. 4. The Finishing Machine.

against the end of the upper belt, which latter is then removed and the scarfed end of the lower belt is scraped off slightly up to the line of the straightedge, thus making an accurately formed seat for the bevel of the upper belt. This results in a joint with no ragged or projecting edges. In cementing, a stiff brush is used to rub the cement into the pores of the belt, only a small quantity of the adhesive being applied; and then the joint is placed under the press for several minutes while hydraulic pressure is applied and the cement allowed to set. When a belt 50 or more inches wide is required, parallel strips of leather must be joined together and this is done by butting the pieces longitudinally and allowing the two thicknesses of leather, or three thicknesses, according to whether it is a double or triple belt, to overlap and break joints as in Fig. 3.

After the required length of belt has been glued up it passes to the finishing machine. The belt is here drawn between stationary knives, which are set the required distance apart to trim the edges of the belt, rounding them slightly and making the belt of a uniform width. In its passage

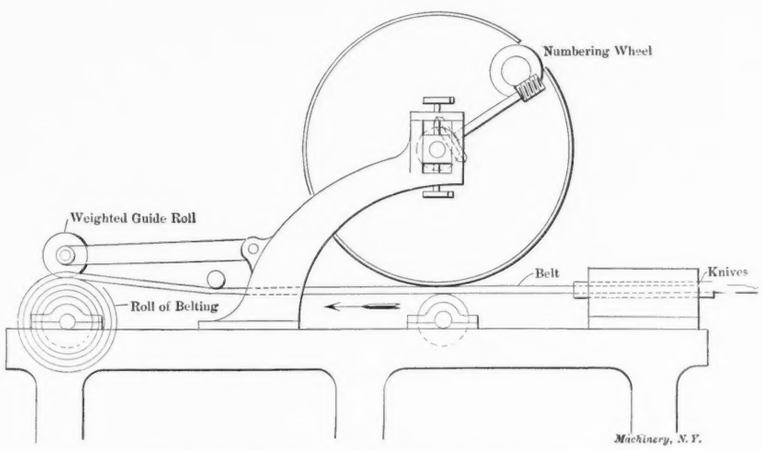


Fig. 5. Diagram showing Mechanism of Finishing Machine.

through this machine the belt is stretched and it also travels under a large wheel, in the rim of which is a numbering die; the circumference of the wheel is 10 feet, so that at each revolution a number is stamped on the belt, indicating its length in feet. The belt is finally coiled or wound on an arbor. In Figs. 4 and 5 are views of the finishing machine, which are self-explanatory. The arbor on which the belt is coiled is driven by a train of gearing and by this means the belt is drawn through the machine under tension.

Various kinds of belting are made to suit the requirements of customers. A belt with cemented lap joints is considered to be as strong at the joints as at any other point, but some customers prefer to have the joints riveted also. Certain brands of the highest grade double and triple belts are stitched lengthwise with heavy thread to render them doubly secure against pulling apart. The same object is also attained by screw fasteners. The screws are originally in the form of a threaded wire wound on a reel mounted on top of the hollow spindle of the machine that inserts the fasteners. The wire passes down through the center of the spindle and is gripped by a chuck at the lower end. As the spindle rotates the wire screws itself into the belt a predetermined distance, at which point it is cut off just beneath the surface of the belt by cutters or

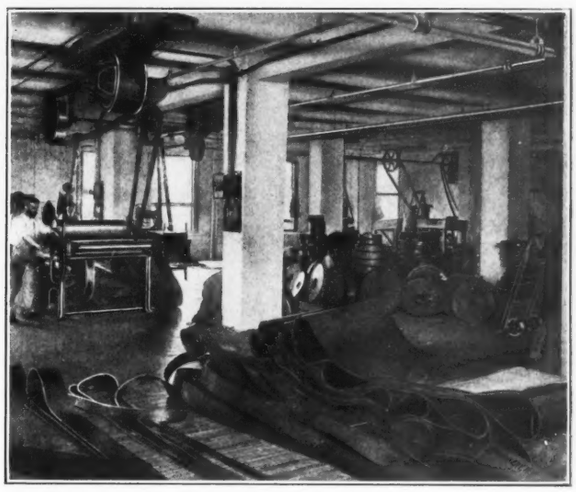


Fig. 6. General View of Finishing Room.

nippers controlled by the machine. Belts which run in damp or otherwise unfavorable locations must be made water and oil proof. Especially is this desirable in the case of belts for dynamos or other rapid-running machinery, where oil is likely to be thrown off the pulleys onto the belts. Link belts are manufactured here, round belts, braided rope belts, and other products of a like character.

The leather used by Charles A. Schieren & Co. comes from their own tannery at Bristol, Tenn. This is in the heart of the oak country, since oak-tanned leather should be exclusively used for a high-grade product like belting. The bark is stripped from the trees in the spring, when the sap begins to flow up into the trunk and limbs of the tree, and is stored in sheds where it seasons for future use. The hides, which come from the slaughter houses of the West, are washed in water to remove the dirt, then placed in vats of weak lime water for several days, until the hair has been loosened sufficiently to allow it to be scraped off with a blunt knife. The hides are then saturated by a neutralizing solution called "bate," which removes the lime, and then they are ready for tanning.

The bark is crushed and delivered to leach tubs, where moisture is applied by means of rotary brass sprinklers. The water filters through this mass, carrying down the tannic acid, which is collected and used in the tanning vats. The process of tanning requires in all a period of 120 days, after which the hides are oiled on the grain side, then hung up in a darkened loft, where they are kept at an even temperature and gain a clear russet color which characterizes leather prepared by this process. The leather is finished by shaving and scouring, part of this work being done at the tannery and the balance at the New York factory, as mentioned above.

CAN BOTTOM PUNCH AND DIE.

W. VAN ORMAN.

The accompanying illustrations show a punch and die for producing the can bottom shown in Fig. 3 at one operation. The die is of composite construction and is, I think, of somewhat novel design, being constructed differently from any other that I have seen.

The punch and die are shown in perspective and cross section in Fig. 1. The body of the die *L* is made of cast iron. The central portion is made the size of the raised or embossed part of the can bottom. The rings *G* and *H* are made of tool steel, while the outer ring *F* is of cast iron and is held to *L*

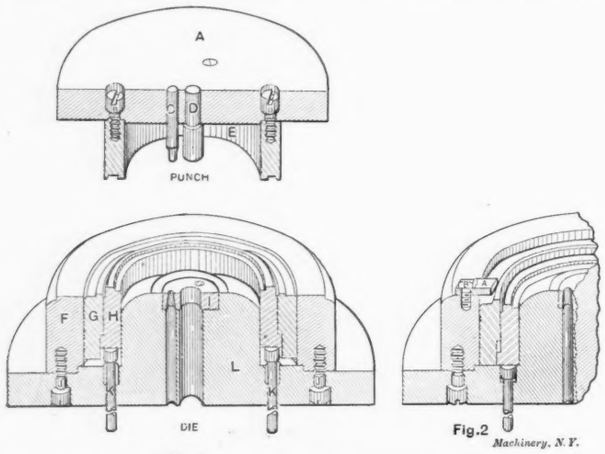


Fig.1
Sectional and Perspective View of Punch and Die.

by the fillister head screws *J*. It will be noticed that a small raised portion or flange is left on the piece *L* about 3/16 inch high for the purpose of centering the ring *F*. The ring *F* was made a driving fit on the flange so there is no chance for it to change its relative position with the remainder of the working parts of the die. The ring *H* might be called a combination forming and cushion ring, the desired form being cut into the face of the ring as shown. *G* is the cutting ring or die which trims off the metal from the can bottom after it is formed. The disk *I* is made of tool steel and it constitutes the piercing or perforating die for the four holes in the bottom. The part *A* of the upper half or punch part is made of cast iron while the other parts *C*, *D* and *E* are of tool steel. The

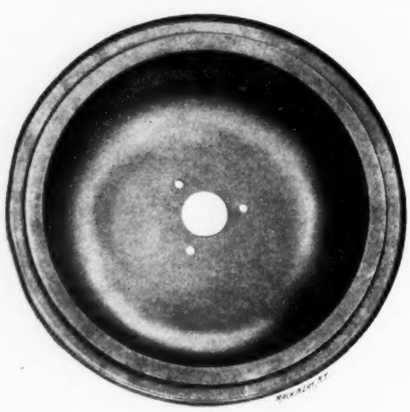


Fig. 3. The Completed Punching.

ring *E* is turned the desired shape and size and, of course, the thickness of the metal used is taken into consideration. It is fastened to *A* by the screws *B* and in this case, also, a boss is turned on *A* over which the ring *E* is made a driving fit. This saves doweling to prevent the ring changing position.

Fig. 1 shows the die before the piece is formed and illustrates the relations that the different parts bear to one another; Fig. 2 shows the die as it would appear after the piece is formed and before the ascent of the ram. It will be noticed that the ring *G* is counterbored at the bottom and that a corresponding flange is turned on the ring *H;* this construction will be explained later.

Before the sheet material is fed into the die it is cut into squares of 8½ inches across, which shape enables the operator to feed the die with more facility. After the die has been set up in the press and everything is in readiness the metal is placed upon the die between the gages *A* shown in Fig. 2, these being four in number. The press is then "stepped," and as the ram descends the metal is gripped between the punch *E* and the ring *H*. When within ⅛ inch from the bottom of the stroke the metal is cut or trimmed from the forming piece by the cutting ring *G* which is made ⅛ inch longer than the ring *H* for the express purpose of trimming the metal before the form of the piece is completed. The ring *H* continues its descent until it bottoms, as shown in Fig. 2, and, as the piece at this moment has not received a complete form, there is just enough draw to the metal to pull it away from the outside and to allow of its being thrown down on the outside, as shown, which gives it a start, or to use other words, enables it to be worked to better satisfaction while being double seamed.

At the same time the piece is being formed the holes are punched by the four punches *C* and *D*, which are made just long enough to penetrate the metal. On the up stroke of the press the rings are forced back to their original places, by the cushion pins *K*, of which there are six all together. The ring *G* being counterbored, and with the ring *H* flanged to fit, it carries the ring *G* with it and the gages *A*, as shown in Fig. 2 also act as a stop for the ring *G*, and keep it from pull-

Fig. 4. The Way the Product Looked before Air Holes were made in the Dies.

ing out with the punch. These rings are all made a nice working fit, in their respective places, and the cutting ring *G* is hardened and ground to size.

There must be air or vent holes drilled in this die for the escape of compressed air; otherwise the die will produce bad work. I show herewith, Fig. 4, a can bottom which came from the die before there were any air holes drilled and it will be plain to see the effect which air has upon the work. Fig. 3 shows a bottom formed by same tools after the air holes were provided.

* * *

EMERSON P. HARRIS ON TRADE JOURNALISM.

The concluding lecture of a series on similar subjects before the evening class at the West Side Y. M. C. A., New York City, was on the topic "Trade Journalism." Besides the members of the class, the trade papers and the advertising agencies were well represented in the audience. The speaker of the evening, Mr. Emerson P. Harris, holds a unique position in the publishing field; he is probably the only man living who has as his sole occupation the selling of trade papers on commission. This business he pursues, not only with considerable profit to himself, but with advantage to the publisher as well, because, before he undertook it, there was no established basis of value and a comparatively restricted market for trade publications; and the mere fact that one was for sale often invited suspicion of its value. Mr. Harris has therefore done for the trade publications what the Stock Exchange does for securities—he has created a market and established a basis of value which makes the sale of a legitimate trade publication no more difficult than the sale of a standard railway security.

Mr. Harris, in opening his remarks, referred to the fact that the trade or "technical" paper, as he preferred to call it, differs radically in one respect from any other branch of journalism. This point of difference is the unusual price per subscriber which the trade journal is able to command as an advertising medium for commodities within its field, and it may be laid to a number of reasons. For one thing, it speaks to a selected audience. When a stove polish manufacturer erects a billboard on the Jersey meadows, his sign is obtruded upon the unwilling passenger who is being hurried to his work, only half awake, perhaps, or is returning home hungry and tired after his day in the city. It is the hope of the advertiser that out of the many thousands who pass his sign daily, there may be some one in a receptive mood who will retain the name of his commodity and inquire for it when next he has occasion to buy supplies. On the other hand, the manufacturer who advertises in a trade journal has the assurance that the man who sees his advertisement is, first of all, interested in the goods there offered, else he would not have subscribed for the paper; second, this advertisement meets his eye at a time when he is interested in the subject, else he would not have the paper in his hands; third, the editorial and advertising pages in a technical paper are of necessity so correlated that the reader is put into a receptive frame of mind for whatever of novelty and excellence there may be in the product of the advertiser. In this last particular especially does the field under consideration differ from that of the popular weekly and monthly journals. In these papers the editor ofttimes gives considerable valuable space to pleading for "high thinking and low living," while the advertiser just as strenuously works for the doctrine of "high living and low thinking."

In judging as to the value of a given paper from the advertising standpoint, quite often the mere matter of size of subscription list bears little relation to its effectiveness. In this field the quality of the list is far more important than its size In some trades it is quite conceivable that, if the paper went into the hands of a certain 200 or 300 men, its advertising effectiveness would reach a maximum and any further increase in the list would be of no direct benefit to the man with goods to sell. The true way, then, to express the value of a paper as an advertising medium is by stating it in terms of percentage of ground covered. Mr. Harris suggested that it would not be entirely beside the mark for an advertiser to ask that he be allowed to examine the subscription lists of a paper to determine what percentage of the men he desired to reach were there represented. Some efforts in this direction have been made by one large advertiser, at least.

The speaker was occasionally interrupted by questions from his audience. In fact, the latter part of the allotted time was entirely taken up in this way. A great number of points were covered. In answer to a question as to the relative standing of American and foreign engineering papers, the speaker gave it as his opinion that the English and continental journals are exceptionally good in the field of general engineering, but are not specialized to anything like the degree that they are in this country. This makes them inferior as advertising mediums, since their subscription list is thus not so rigidly confined to those interested in a given business.

Another question related to the comparative importance of the advertising and editorial departments of the paper. The speaker considered that this question was in a way beside the mark. One might as well discuss the question of the relative importance of the heart and the brain. An intelligent and progressive editorial policy gives a paper the standing which makes it a good advertising medium, while the advertising, in turn, makes it possible to keep up or raise the standard of the editorial department. One of the advertising men present briefly referred to the way in which the editorial policy of a journal affects the interest of the advertiser, giving, as examples, the names of certain publications which he would recommend to his clients simply from the standing which the excellence and intelligence of the matter in the reading columns had given them.

Mr. Harris described some of the difficulties the editor has to contend with. One of these is the tendency to secretiveness on the part of those who are possessed of information and material which would make readable copy. Another is the continued and persistent temptation which is always with him to yield to the pressure for notices and write-ups in the reading pages of the paper. This temptation is especially insidious from the fact that no line can be drawn between matter which is primarily of interest and novelty to the reader, which yet incidentally serves as an advertisement to the manufacturer concerned, and matter which is boldly and openly an editorial advertisement. Within the first class mentioned, and bordering on the second, lies the greater part of the material available for publication in the reading pages, and the judgment and firmness of the editor has constantly to be exercised to preserve the integrity of his department. Considering the temptations to which he is subjected, Mr. Harris kindly volunteered the opinion that the editor of a trade paper who adheres to an honorable and intelligent editorial policy, is possessed of a rugged and well-tried virtue, rather than the merely negative quality of innocence, which might characterize a man whose calling is less beset with specious allurements.

* * *

A WOULD-BE WATCHMAN'S APPLICATION FOR A JOB.

————Jct., August 12, 1905.

———— —— ———— —— Co., Chicago, U.S.A.

Dear Gentlemen:—I see by the Globe paper where you's have purchased eight acres on the west side of the G. T. R. tracks in the city limits, not far from the Jct limits, knowing the place well. I see that you's are making preparations to build large shops for Mfging. I will offer my service as night-watchman to you's when you are ready. I am a young man single 29 yrs of age, 5′ 6″ height, weight 150 lbs, strict & temperate free from chewing, drinking & smoking. Born and raised on a farm, 60 miles from the Jct., northwest with in 32 miles from Collingwood, there were three brothers of us and my father for the 100 acre of land and there was not enough of work for all of us, and I went threashing with a man, I done the firing and running of the engine I followed this up 5 yrs, an then I purchased a out fit for myself. A traction engine and separator, turn a round an sold the separator to a nother man that broke his own, an I kept my 18 h. p. engine and I went around cutting feed & choping grain & cutting wood with a circular saw. Then the man that bought my separator bought a clover separator & got me with my engine to go an threash clover in the fall an all winter and right up till the snow went in the spring. I followed this up for 3 yrs more & sold out. Since this my father died, an my youngest brother he went to the west & took up land there & I rented the farm to my 2nd youngest brother. An I moved my Mother & Sister to the Jct & we bought a lot & built a house on ——— Ave., No. 94 ———— Jct. to live privite. For references I can give you 35 or 40 names of good men that knows what I am. I will take $675. a year for 10 hrs. a nignt Or $750 or $725 a year for 13 hrs. a night. My idea on night watching is this A night-watchman should go on duty 1 hr. before a factory shuts down for the night, the reason is this, he is making his first trip through the factory & he can have an eye on the employees & see how they leave things when they are going out or catch them in the act of lighting their pipes, as some does when they are leaving the shops & throwing the match down thinking that they have blown it out. It is nothing but right down carelessness of men & night-watch men that causes all those big fires in factories. I often ask people what do they engage nightwatchmen for, they say to watch buildings in case of fires might start, and I have said to them what do they let the fires start for, & they would say that the nightwatch-man was not doing his duty when he would let a fire start. I'll ask you's to equiped your factory with electric registry system connecting with the detective department at the city Hall. A good night-watch-man is a man *that will do his duty.*

Yours Truly,

———— ——— ————.

* * *

Don't forget that a lathe tool is liable to draw into the work if it is set below the center for external work; with internal work the danger is when it is above the center.

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MACHINERY

REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66-70 WEST BROADWAY, NEW YORK CITY.

The receipt of a subscription is acknowledged by sending the current issue. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

MAY, 1906.

PAID CIRCULATION FOR APRIL, 1906,—22,311 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

THE ENTERING WEDGE.

Last December Representative Littauer introduced the following bill in Congress "to fix the standard of weights and measures by the adoption of the metric system of weights and measures":

"Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after the first of July, nineteen hundred and eight, all of the departments of the government of the United States, in the transaction of business requiring the use of weight and measurement, shall employ and use the weights and measures of the metric system."

All the space devoted to reading in this number of MACHINERY would not be sufficient to print more than a fraction of the arguments for and against the introduction of the system in this country, and we shall not undertake it. We are opposed to its introduction because, while the metric system undoubtedly possesses features of great theoretical convenience in experimental and laboratory work, it has no such advantages in manufacturing, and in some respects is inferior to the present system of measurement, as we have from time to time made clear. Its adoption would mean an expense of thousands of dollars and months of work in almost every large plant, to recast drawings and change the present system of gages, etc., which would unquestionably result in great confusion and loss of time, both to employers and employees.

The machinery manufacturers of this country are practically a unit against it. It is possible that these men are lacking in enterprise and blind to their own interests, as the metric advocates claim; but among them are many manufacturers who for years have made a study of Continental methods, and their unanimous opinion that the adoption of the metric system would not facilitate their work should carry more weight than that of the foreign engineers who are showing so much anxiety lest America should "find herself isolated and left behind" in the race for commercial supremacy.

The bill referred to appears to be mainly supported by theorists who have little or nothing to lose by the change, while its opponents are all manufacturers who would be put to heavy expense and their business disturbed. It is an apparently innocent piece of legislation, by which the use of the metric system is required only in the government departments; but this is believed to be the entering wedge to force the adoption of that system in this country, and our machinery interests do not want it.

THE SNOUT BORING MACHINE.

There are certain principles of machine design that do not seem to be fully understood, or if understood are not appreciated as they should be. One of the most important is that no matter how strong and rigid a machine is built it must necessarily be displaced in its working parts to some extent, but deflection is not necessarily productive of inaccuracy provided the amount of deflection is uniform throughout the course of a machining operation. For example every mechanic knows that it is possible to produce a true bored hole with a slender boring tool held in a lathe tool post, provided he takes the necessary time and precaution in grinding the tool, etc. The tool may be so slender that it is easily sprung out of place by the hand but the deflection is practically the same at all points of its travel while boring the hole. If the attempt is made to support the boring tool in a bushing so as to make it very stiff at the beginning of the operation the result, of course, will be a tapered hole for, as the cutting edge of the tool travels away from the bushing, it will be deflected more and more by the pressure of the cut.

After these preliminary remarks we wish to call attention to the principle of the snout boring machine which is a tool that has attracted very little attention in this country, although used in some British and European shops. The principle of its construction is simple, being essentially embodied in a table on which the cylinder is mounted and an overhanging arm carrying at its extremity a boring head, the bar or driving shaft being supported in the arm. The length of the overhanging arm is such as to cover the length of the hole to be bored, the cylinder and table being fed longitudinally as the cut proceeds. While the rig is not of the stiffest possible construction, being unsupported at the outer end of the arm, its deflection is uniform at all points of the cylinder bore for the same pressure of cut. Hence a roughing and finishing cut always suffices to make a hole with parallel sides. Cylinders with one end solid are bored with the same facility as when both ends are open and for this reason this type of boring machine is one that is particularly adapted to the manufacture of gas engine cylinders. Some of the builders of vertical gas engines are using this form of boring machine, in which case they are able to avoid the use of a screwed top head. But many of the manufacturers are using boring bars supported at both ends which necessitates a hole through the top head in which a screwed head is inserted when the cylinder is erected. This construction means extra cost and adds practically nothing to the value of the engine.

* * *

An editorial note appeared in the April issue on the choosing of a firm name, mentioning the more or less obvious fact that a firm name should indicate both the place and the character of the business, if possible. Then the matter of remembering firms and their locations is simplified. In this connection we would also suggest that it is not a very good practice for a firm to give a distinctive trademark name to a machine as, for example, the "Sun" boring mill or the "Atlas" shaper. We have received from time to time inquiries for the names of tools or machines bearing such trademark names, and when, as often occurs, the makers have ceased advertising these tools, it requires either a good memory or a lot of looking up to discover by whom and where the machine was manufactured. In our opinion it is far preferable that a machine be known as the "Brown & Smith" lathe than to give it a fancy name which means nothing and does not even have the merit of locating it, except as the advertising may have associated the trademark name and the firm together. Of course there are certain products which are preferably distinguished by some name as, perhaps, is the case with tool steels. There are, as everybody knows who uses tool steels, a great variety of fancy names of more or less catchy form used to distinguish the different brands, but the same trouble occurs with them, for people remember the brand long after the name of the maker is forgotten. We have been to considerable trouble in "running to earth" the makers of certain brands and have consequently compiled a list of the makers and trademark names of tool steels, so as to be in a position to readily give such information to those desiring it.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Consul-General Skinner, of Marseilles, writes that the official decree has been published by the president of the French Republic providing for prizes for the following inventions: One prize of 20,000 francs ($3,860) is instituted for the benefit of the person who shall discover a denaturizing agent for alcohol more advantageous than the denaturizing agent now in use, and offering to the "treasury" every guarantee against fraud. One prize of 50,000 francs ($9,650) is provided for the benefit of the person who shall discover a system of utilizing alcohol for illuminating purposes under the same conditions as petroleum.

In a paper, "Gas, Oil and Petrol Engines," read by Mr. Henry N. Bickerton before the Manchester Association of Engineers, March 10, 1906, the statement was made, in reference to the Diesel oil engine, that a test conducted by Mr. Michael Longridge on a three-cylinder inverted vertical 500 H. P. engine of this type showed an oil consumption of only 0.451 pound of Galacia crude petroleum per brake horse power hour. This oil cost about 0.87 cent per pound (£4 per ton of 2,240 pounds) delivered at the power plant. Hence, the cost per brake horse power hour for fuel was only 0.381 cent, or $1.95 per hour for the full power of the 500 H. P. unit.

The copying of illustrations or printed matter by photography is a rather expensive and tedious task when done in the ordinary manner. A contributor to a German publication, according to a note in the *English Mechanic*, suggests a much cheaper and simpler plan. The page or cut to be copied is laid on a table and above it, at an angle of about 45 degrees, is placed a common mirror. The reflection of the matter to be copied in the mirror is focused on the ground glass of the camera, but then instead of using a plate a smooth-faced bromide or negative paper is used for the exposure. The result of course is white letters or lines on a black ground, but this ordinarily is not objectionable. The use of the mirror is necessary to reverse the view which otherwise would be wrong side to.

The oxy-acetylene blowpipe produces a very high temperature, being in the neighborhood of 4,000 degrees C. It promises to be a very valuable means of welding plates together and for other purposes requiring high temperature. The proportion of oxygen and acetylene may be regulated so as to make the flame either an oxidizing or reducing agent simply by giving excess of oxygen or acetylene as may be desired. One great advantage of the new blowpipe is that both oxygen and acetylene gases may be generated as desired thus doing away with the necessity of transporting them in cylinders under high pressure. The acetylene gas is of course generated by the combination of water and carbide of calcium, and oxygen may now be produced by the combination of water and peroxide of sodium which is sold under the trade name of "oxone."

The largest steel ingot hitherto produced was cast last February at the Manchester works of Armstrong, Whitworth & Co., says the *Engineering Review*. This ingot with the weight of 120 tons was made in accordance with the Whitworth fluid pressure system, the molten metal being poured into a mould itself weighing about 180 tons, which was then placed beneath a hydraulic press having a 6-foot diameter ram working at a pressure of 3 tons per square inch. The ingot is intended for the turbines of the new Cunard liner which will develop 70,000 horse power. It is interesting to compare this enormous body of solid metal with the tiny blooms of some three-quarters of a hundredweight which represented the maximum weight of wrought iron producible in a single mass by ironworks half a century ago.

In the discussion of the paper, "The Behavior of Materials of Construction Under Pure Shear," which was presented before the January meeting of the Institute of Mechanical Engineers, reference was made to the well-known phenomenon of there being less metal in a punching from a thick boiler plate than volume in the hole made. Mr. W. H. Maw said that he had ascertained the specific gravity of a number of such punchings and found them to be practically the same as the boiler plate; what slight difference there was indicated that the specific gravity, if anything, was slightly *less* than the plate. His observation was that the metal was displaced into the plate surrounding the hole, thus thickening it to a slight extent in a narrow ring around the hole. Prof. Unwin corroborated Mr. Maw's observation, both as to decreased volume and slightly decreased specific gravity. This decrease of volume is, of course, much more noticeable on thick plates than on thin plates; in fact, with thin plates it does not exist to any appreciable extent.

The Carnegie Steel Co. has just closed a contract with the Commercial National Bank, of Chicago, for the construction of the largest armor plate safety deposit vault in the world, says the *Iron Trade Review*. It will be 46 feet square and nine feet high and the material to be used is the nickel steel Harveyized face-hardened steel identical with that used by the United States government to protect its battleships and cruisers. In addition to this immense safety deposit vault the Carnegie Steel Co. will build for the same company a cash bank vault with interior dimensions 36 feet, by 17 feet by 9 feet high. With the construction of the vestibule to the vaults particular care has been taken, and this vestibule will be 10 feet square, walls eight inches thick, and the door jambs 14 inches thick, forged from one solid ingot of armor plate weighing about thirty tons. The doors at the main entrance will be eight feet in diameter, twenty-one inches thick, and will weigh seventeen tons. The inner doors will be four and one-half inches thick fitted with bolted mechanism controlled by double dial combination locks.

The use of the nickel steel alloy "invar" for shop standard gages has been initiated in Great Britain by W. F. Stanley & Co., London. This useful alloy, as has been mentioned in MACHINERY, is practically unchangeable in any of its dimensions for ordinary changes of temperature, the coefficient being under 0.0000001 per degree F. We have mentioned the use of invar in geodetic survey work for the construction of instruments, and it has been used to a limited extent for measuring tapes although rather soft for this purpose. As to its use in the shop for standard gages there has been some difference of opinion as to the advisability of using a non-changing metal, the argument being that the metal composing a gage should have practically the same expansion coefficient as the metal being measured. On the other hand, however, we know that the gage being handled by the workman is almost always at a higher temperature than the work and, therefore, is more affected by expansion. If the gage were made of a "non-changing" metal, standardized at the average shop temperature, then no matter how much the gage is handled it should register accurately when used under ordinary shop conditions.

The difference between the action of spur gearing and worm gearing has been aptly expressed by stating that the first is an example of lever action while the second is that of wedge action. In the one case friction is present to only a slight degree while in the second case it may be the principal retarding factor. In the discussion of the paper, "Worm Contact," by Mr. Robert A. Bruce, presented before the January, 1906, meeting of the Institute of Mechanical Engineers the difference between the sliding action was pointed out, taking for example a spur gear of, say, 1½-inch pitch, and a worm gear of the same pitch and of the ordinary proportions used in practice. In the case of the spur gear the sliding movement would probably be not much more than ⅛-inch for a certain

case, while with the worm gear it would be, say, about 3 feet. It is, therefore, much more important that the bearing parts be liberally proportioned than with spur gears. Whatever metals are used, the pressure must not be so great that the oil will be squeezed out; if the surfaces are well proportioned the worm gear will give a good account of itself. In short, worm gears must have much larger surfaces in proportion to the power to be transmitted than spur gears, whereas the tendency has been to make the proportions about the same.

"Forced draft," said Admiral Melville in a recent paper, "dates back to Stevens' Rocket, and its first use for marine purposes was by Mr. Robert L. Stevens on the Hudson River steamers in our own country prior to the Civil War. During that war Mr. Isherwood built a number of gunboats which used forced draft, but it had fallen into disuse for naval vessels until about 1882, when it was introduced into the English navy and still later was applied in the merchant service. In naval machinery forced draft has been of the greatest possible importance, because it has reduced boiler weights probably almost one-half. In the navy the natural limitations as to space and weight prevent the use of forced draft with very much economy of fuel. It is obvious that if the rate of combustion is increased from 15 pounds of coal per square foot of grate to 40 pounds, there ought to be an attendant increase of heating surface. In the merchant service, or at least in certain classes of vessels in that service, it is possible to do this, and in one of my annual reports I made a comparison between the boilers of a merchant vessel called the *Iona* and those of the *Baltimore*. In the *Iona* there were 75 feet of heating surface for 1 of grate, while in the *Baltimore* the ratio was about 30 to 1; but had the *Baltimore's* boilers been designed with any such ratio, their weight would have been almost double the weight of all the machinery of that vessel as actually built."

It is not an uncommon thing for a mechanical or electrical idea to be partially developed and then laid aside as being undesirable or even impractical for the time being. Mr. Frank J. Sprague claims that the inter-pole electric motor is an example, and designates it as the reincarnation of the electrical idea in a contribution of his to the *Electrical World*, February 24, 1906. The reason for Mr. Sprague calling attention to this revival of a so-called old idea is a statement made by him some weeks ago that heavy electric operations such as are required for railway trains under a motor potential of not less than 1,500 volts are quite possible and practical; he believes that the inter-pole motor points the way to the design of generators and motors which will work safely and efficiently at what is now considered extremely high voltage for direct current apparatus. The inter-poles being excited with series coils weaken and strengthen with the load and automatically work the same effect as shifting the brushes does with the simple form of motor. In this connection he refers to his United States patents No. 428,732, May 27, 1890; No. 324,891, August 25, 1885; No. 335,781, February 9, 1886, which he claims anticipated the present construction. Whatever may be the status of the patputs on inter-pole motors, the fact is that the design is very successful. It makes the variable speed motor a great success and will no doubt greatly simplify the design of certain machines which now require considerable gearing to give the necessary speed variation.

Electromagnetic guns have repeatedly been proposed, says *Engineering*. A few years ago Professor Birkeland, of Christiania, whose name has become widely known by his successful fixation of the atmospheric nitrogen, actually experimented with model guns of this type. In the *Mitteilungen über Gegenstände des Artillerie und Geniewesens*, Captain A. Spacil, of the Austrian Artillery, deals at some length with the energy problem of such devices for steel and iron projectiles. He concludes that to impart a muzzle velocity of 1,640 feet per second to a projectile of 88 pounds, to be shot from a 43-calibre 5.9-inch gun, would require 600 coils of 7,216,000 feet of 0.059-inch copper wire, weighing 9,250 pounds, and at 181 volts per coil, a current energy of 54,300 kilowatts. These figures are of the same order as those which Birkeland gave for his gun, which was to hurl projectiles of 4,400 pounds with a velocity of 1,000 feet per second; he wanted 1,620,000 kilowatts (2,170,800 H.P.) at 3,000 volts. There is no power station in existence which could produce anything like this energy. Considering, however, that the energy would be required only for a fraction of a second, special machines might be devised for the purpose. Birkeland suggested that the primary generator should consist of a powerful electromagnet which was to be shot, by explosive power, through coils wound round a copper tube. He thus proposed to start from explosive energy in order to obtain, after three conversions, electromagnetic energy for the propulsion of projectiles. The efficiency of such combinations could not be but very low.

Mr. A. M. Mattice, at the December meeting of the A. S. M. E., in the discussion on "Bearings" objected to the drop by drop system of oiling. It tends to niggardliness in the supply of oil and actually induces waste, since the oil is liable to be burned and practically useless after going through the bearing once. For surface working under severe conditions the forced-oil system may be used to good advantage. It has the disadvantage of depending on a pump, which may fail to operate at the most critical moment. The proper method for most conditions is to lubricate all important bearings by the flooding system from a reservoir of sufficient capacity, located high enough to give a few feet head to the oil supply. This oil may be used over and over again, does not get dirty, and serves to carry away the heat generated by friction, as well as to lubricate the bearing surfaces. Mr. Mattice gave a number of examples showing the economy of this method of oiling. The steamer *Alexandria*, of Liverpool, driven by three turbines whose main bearings are oiled by this system, used in a season of four or five months only one barrel of oil. One turbine and generator of 1,000 kilowatts capacity averaged about half a gallon per week oil consumption.

The speaker also referred to the fact that bearings may be run continuously at much higher temperatures than common practice admits. This common practice he considered to be a prejudice dating from the time when vegetable and animal oils were exclusively used. With modern mineral lubricants a bearing temperature of 130 to 150 degrees F. is perfectly safe, and in one case an engine ran constantly month after month with a bearing temperature of 180 degrees without the slightest distress.

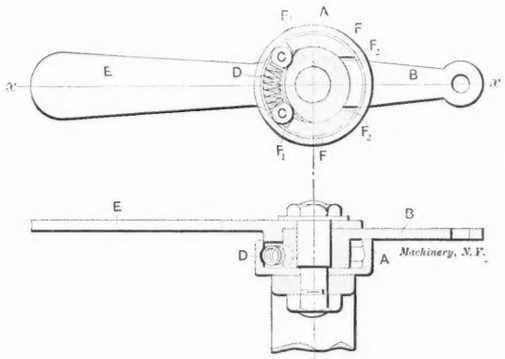
GASOLINE VS. DENATURIZED ALCOHOL.

In the hearing given by the Committee of Ways and Means of the House of Representatives on the subject of untaxed denaturized alcohol, Mr. Leonard B. Goebbels, representing the Otto Gas Engine Works, of Philadelphia, spoke interestingly on the gasoline engine and the dwarfing effect that the scarcity of gasoline is having upon this motor industry in the United States. He stated that owing to the rapidly increasing cost of gasoline, the use of it is now restricted to the smaller engines, say up to 30 horse power. In Germany, however, the building and selling of alcohol engines in the larger sizes is rapidly increasing because of the cheapness of this fuel when untaxed. Alcohol may be used the same as gasoline in engines designed for gasoline. For a given cylinder capacity an average of about 20 per cent more power is developed with alcohol than with gasoline. This is due to the fact that alcohol gives a higher thermodynamic efficiency than gasoline, although its heating value per volume is only about as 1 to 1.6; the thermal efficiency is about 21 per cent for gasoline as against 30 per cent or more for alcohol. A feature of the alcohol engine that will be appreciated by those who have suffered from the vile fumes discharged by gasoline engines when working badly is that the exhaust gases from alcohol are practically odorless; aside from being odorless they contain 20 per cent less of obnoxious constituents than gasoline. This is particularly valuable where motors have to be used in mines or other places where ventilation is imperfect. Again, alcohol is much less dangerous than gasoline; in fact there is little or no danger of explosion with alcohol. A test was mentioned in which a surface of 6 inches square was covered with equal volumes of gasoline and al-

cohol. The alcohol took twice as long to evaporate. A small quantity of gasoline was placed in a receiver in an iron bucket and tried for explosive effect. At the end of half an hour the bucket was filled with an explosive mixture so that a lighted match dropped in the bucket caused explosion. The same experiment tried with alcohol failed entirely, although it was allowed to stand a much longer time.

NOVEL LEVER LOCK.

The accompanying cuts, taken from the *Engineering Review*, show an English lever lock which is being exploited by the Finchley Motor & Engineering Co., Finchley, England. The principle of the device is such that the hand lever *E* may be readily shifted but the operated mechanism connected to *B* is always securely locked in position the same as is the case with a worm and wormwheel. In fact the device offers a reliable substitute for the worm and wormwheel without the loss of mechanical efficiency generally resulting from the use of such a device. The upper cut shows the plan and the lower one the side section of the device applied to the throttle or ignition adjustment of an internal combustion engine. The lever *B* may be set in any position within the limits of its movement by the manipulation of the hand lever *E*, but as soon as the latter is released the lever *B* is locked. The locking device consists of two balls *C* lying in an annular space formed between the locking lever *B* and the case or cup *A*. This space it will be observed diminishes in width from the center line *x x* outwards in both directions, and the balls are separated



Novel Lever Lock.

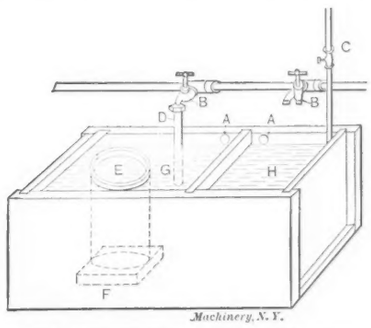
by the spring *D* which pushes them apart and keeps them in close contact with the interior surface of the cup and the exterior cam surface of the lever *B*, locking the latter securely in place. The operating lever *E* is mounted on the same axis with lever *B* and has two lugs *F* whose faces F_1 closely approach the balls in the locked position. When the lever *E* is shifted in either direction it loosens the ball which comes into contact with the lug and further movement brings the face F_2 of the opposite lug in contact with the side of lever *B* and moves it approximately through the same angular distance as *E*. Movement of the operating lever *E* in the opposite direction accomplishes the same result. The moment the actuating force is relieved from *E* the spring pushes the balls tightly into the tapering portions of the recess and so locks the lever *B* immovably in the cup *A*.

BRIGHT DIP FOR BRASS CASTINGS.

What is known to the trade as bright dip is absolutely indispensable in the manufacture of brass goods; this dip will be found in connection with every brass foundry, large or small, and has been in use a great many years, Mr. H. J. Hawkins says in the *Foundry*. It has never been improved upon as far as the results are concerned, but it is always found a very disagreeable and unhealthy solution to work over, and where it is required to dip large quantities of work special facilities should be arranged to carry off the fumes.

Where first-class work is expected and required it is of the utmost importance to have the dipping arrangements as nearly perfect as may be. A very simple and convenient arrangement for acid dipping is shown in the cut. The tank should be made of good pine, free from knots, or oak, and well bolted. Line the cold-water compartment *G* with asphaltum inside, and the whole tank should be well pitched on the outside, leaving the inside of part *H* to contain the hot water free from pitch. The clean water should be carried to bottom of tank by means of hose *D*, allowing the dirty water to be carried off by the discharge pipe *A*, the top of which should be about four inches below the top of tank. A wooden hood should be built over this tank to carry off the fumes. The water in *H* is heated by steam from the pipe *C*.

The standard formula for the bright dip for brass work is as follows: Sulphuric acid, 4 gallons; nitric acid, 2 gallons, stirring in a small handful of salt, using a glass rod for stirring. Sometimes an ounce or two of lampblack is added to



Tank Arrangement for Brass Bright Dip.

this dip with beneficial results seen in the finish obtained on the work. This dip should be kept as free from water as possible, as water weakens it and causes it to lose its activity. It is the general practice in dipping brass castings to dip them directly from the cold water into the acid dip. This is wrong; the work should go into the bright dip dry, or nearly so. It is the best method to run the work through the hot water in *H*, shake off, then into the bright dip in *E*. In this way the work will go into the dip dry, or nearly so, thereby increasing the life of the dip. Some work, especially new castings, must be dipped twice and often three times, where a fine even color is required. After dipping, rinse quickly in cold, then hot water, and dry in sawdust, using "hardwood sawdust."

UNTAXED DENATURIZED ALCOHOL.

Statement of Hon. James Wilson, Secretary of Agriculture, before the Committee of Ways and Means, House of Representatives, February 7, 1906.

The question of heating and lighting on the farm is becoming quite insistent. In the prairie countries there is some coal, but the readily obtained supply will become exhausted before a very remote date. Hard coal taken out to the prairies is expensive at all times, and very expensive quite often; besides which, it is becoming more and more expensive as time goes on, so that we must begin looking about for other sources of heating and lighting. The starch and sugar plants are the present source of alcohol and will continue to be. In Europe the chief sources of alcohol have been the potato and the sugar beet by distillation, either directly or from their by-products. Other sources of alcohol which may be advantageously utilized in the United States are the white potato of the North, the sweet potato, the yam, the cassava plant, waste molasses from the sugar cane, waste molasses from the sugar beet, and the waste product from the stalk of the indian corn at the time of the hardening of the grain. In this list may be included all plants that yield heavily of starch or sugar.

The term alcohol as I am using it does not apply to any alcoholic beverage, but to pure or denaturized alcohol in a form suitable for technical uses and so mixed with other ingredients that it cannot be used as a beverage. Sugar and starch, on fermentation, yield about half their weight as absolute alcohol. In practice a smaller quantity is obtained because of certain by-products, such as acids, which are produced during the fermentation of sugar and starch. Practically it may be said that 45 per cent of the raw material—that is, the sugar or starch—is obtained as alcohol.

It is becoming an interesting question in what direction the

people will turn for heating and lighting, considering the increasing price of coal and the diminishing supplies of wood. An acre of land which produces 50 bushels of corn, nearly 2,800 pounds, will furnish 1,960 pounds of fermentable matter; that is, starch and sugar together. Forty-five per cent of this will be obtained as absolute alcohol, namely, 882 pounds. A gallon of absolute alcohol weighs 6.8 pounds; therefore an acre of corn would produce about 130 gallons of absolute alcohol. Commercial alcohol is about 95 per cent pure, so that approximately an acre of indian corn producing 50 bushels would make about 140 gallons of commercial alcohol.

If we assume the average crop of potatoes to be 300 bushels, or 18,000 pounds, it would produce 3,600 pounds of fermentable matter, since the potato contains an average of 20 per cent of this material. This would produce 1,620 pounds of absolute alcohol, or about 255 gallons of commercial alcohol, showing that an acre of potatoes produces much more alcohol than an acre of corn.

But there is another consideration with regard to the potato as a source of alcohol. We raise potatoes for human food, and for scarcely any other purpose. We plant the potato that has the finest flavor for the table, independent of its yield per acre. Were we raising potatoes for the purpose of making alcohol, these considerations would not be regarded. The variety of potato that would give the largest yield per acre would be planted. Where potatoes are used as cattle food, as they are in many foreign countries, varieties of this kind are resorted to, and there would be no difficulty whatever in doubling the 255 gallons per acre receivable from the present average yield of potatoes. So that it would be within bounds to say that 500 gallons of alcohol can be had from an acre of potatoes.

Potatoes, moreover, are a commercial crop only when within a certain distance of market. At the average price at which the potato sells it can be hauled only a short distance, but when looking to it as a source of heating and lighting, factories would be erected in country neighborhoods, and the potato would then be grown for its largest possible yield of alcohol. The sweet potato and the yam contain about the same quantity of fermentable matter and would yield equivalent quantities of alcohol.

So, looking at this subject from the agricultural standpoint, we find that the Northern States could readily depend upon the white potato as a source of heat and light, the Southern States upon the yam and the sweet potato, and the Western States upon the sugar beet. The extensive irrigation projects now being carried on by the United States government will result in watering lands that will produce sugar beets more profitably, perhaps, than any other crop. The molasses can be readily turned into alcohol.

The stalks of Indian corn, at the time when the grain is sufficiently hardened to be perfectly sound, when harvested contain a large quantity of starch. If the stalks of Indian corn could be utilized at that time for the manufacture of alcohol, they would produce a quantity which would be almost incredibly large. There would be approximately 10 tons of stalks to the acre of Indian corn yielding 50 bushels the acre, or 20,000 pounds, and of this at least 12 per cent, or nearly 2,400 pounds, is fermentable matter, 45 per cent of which can be recovered as alcohol, equivalent to 1,080 pounds of absolute alcohol, or approximately 170 gallons of commercial alcohol. The average yield of Indian corn is only about one-half the above, but the heavier corn lands of the country that would be used for growing corn for alcohol average easily 50 bushels to the acre. It is safe to say that the average amount of sugar and starch which goes to waste in the stalks of Indian corn annually would make 100 gallons of commercial alcohol per acre. When we consider the vast number of acres cultivated in Indian corn, approximating 100,000,000, it is seen that the quantity of alcohol that is lost in the stalks is so large as to be almost beyond the grasp of our conception.

Of course, it must be remembered that there would be very great difficulties attending the saving of these stalks and the manufacture of alcohol from them, and as long as there are cheaper sources it is evident that they will not be utilized for this purpose. But the time is doubtless coming when technical and commercial skill will be able to utilize this immense source of energy. Our coal mines are definite quantities and are being rapidly used up. Our forests are disappearing and many of them have disappeared. The same is true of the sources of mineral oil and natural gas. In the future—it may be some time in the future—the time will certainly come when the world will have to look to agriculture for the production of its fuel, its light, and its motive power. It seems to me that through the medium of alcohol agriculture can furnish in the most convenient form for the use of man this absolutely necessary source of supply. I believe, therefore, that the utilization of alcohol in the arts and industries, under such restrictions as would safeguard the fiscal rights of the United States Government, would prove not only a great stimulus to manufactures, but a great benefit to agriculture.

SOME TURBINE FALLACIES.

R. M. Neilson, in Power, March, 1906.

Although steam turbines are now much better understood by engineers in general than was the case a few years ago, there are still many prevalent fallacies concerning them and much ignorance on certain points in their theory of action.

Turbines were first used for the propulsion of ships in Great Britain, where they were employed first on the *Turbinia*, which was an experimental vessel built on the lines of a torpedo boat, and then on the destroyers *Viper* and *Cobra*. These were all very speedy vessels and the largest, the *Cobra*, was only 400 tons displacement. Hence, an idea rose that steam turbines for the propulsion of ships were most suitable for small, fast vessels, especially torpedo craft.

Now, there is no reason why turbines should be more suitable for small vessels than for large vessels; and for torpedo craft, turbines have the disadvantages that they have not as yet been got to drive a vessel economically at widely-varying speeds. Turbines would really seem to be most suitable for large highly-powered steamships intended to run always at their highest speed.

The advantage of having large diameters in steam turbines is not always understood. It is often supposed that the large diameter is preferred in order to give the steam a great leverage and so, it is argued, obtain a greater turning effect. The real reason is to allow of a less angular velocity; that is, fewer revolutions per minute being obtained. No matter what be the type of turbine, with a given number of stages or wheels or sets of moving vanes and a given boiler pressure and superheat, if any, and a given condenser vacuum, there is a certain vane speed which is best. Now, increase of diameter allows of a given vane speed being attained with a less angular velocity. Therefore, to keep angular velocities low, diameters are made great.

Angular velocities are often limited, notably, in the propulsion of ships. With marine steam turbines of the Parsons type efficiency and low cost are often sacrificed to a certain extent in order to get large diameters and to obtain low angular velocities to suit the screw propellers.

It has often been proposed to cause a steam jet to give up some of its velocity to accelerate another fluid and then utilize the mixture to drive a turbine. Exhaust steam, water and even mercury have been proposed as the diluting fluid. The idea is that by this device a lower velocity is obtained and that, therefore, a lower vane speed can be adopted without loss of efficiency.

This is true; but a little scientific consideration will show that the loss is likely to much exceed the gain. Take a simple case: Suppose that the steam jet has a velocity of 4,000 feet per second and that it mixes with an equal weight of diluting fluid which was previously at rest. The total momentum must remain constant and, therefore, as the moving mass is doubled, the velocity of the mixture must be half that of the original steam jet; that is, it will be 2,000 feet per second. Now two pounds of fluid with a velocity of 2,000 feet per second have only half the kinetic energy of one pound of fluid with a velocity of 4,000 feet per second, because the kinetic energy is proportional to the square of the velocity. The diluting scheme has, therefore, caused the loss of half the kinetic energy of the steam. If, instead of diluting the steam of the jet, the vanes of the turbine had just been run at half

the best speed, the loss caused thereby would not have exceeded 25 per cent of the initial kinetic energy of the steam.

It may be asked where the energy goes to that is lost in the diluting scheme. It produces heat of impact and eddies. These forms of energy may be utilized to a certain extent if the steam is expanded further after leaving the vanes just considered, but the useful work obtained from them will be only a small part of the kinetic energy wasted. Besides, if the jet had not been diluted but, instead, the vanes run at a speed less than that called for, the steam would have left the wheel with a considerable velocity which could have been turned into heat and utilized in part in the following expansion.

It is not surprising, therefore, that diluting for the purpose mentioned, although often proposed, has never got past the experimental stage. Diluting to reduce temperature is a totally different thing. This has been proposed in the case of turbines actuated by hot gaseous products of combustion and has much to be said in its favor.

GAS ENGINE ECONOMY.

From a Paper Read by C. E. Sargent upon the "Prime Mover of the Future," before the Western Society of Engineers, December 6, 1905.

There are three dispositions of the heat in the fuel which goes into a gas engine cylinder: Part of it, usually about 25 per cent, goes into work; about 40 per cent into the water jacket, and 35 per cent into the exhaust, radiation, etc. Now, if we can reduce the amount which is wasted, we of course increase the percentage turned into work. The amount going into the water jacket depends, other things being equal, on the amount of surface exposed during the inflammation of the

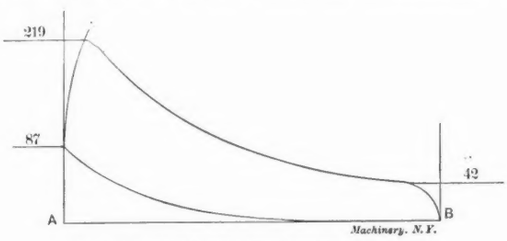


Fig. 1. Typical Otto Cycle Indicator Diagram.

charge. The higher the compression the less surface surrounding the unit of compressed charge, therefore less heat is wasted. The Lenoir engine, firing at atmospheric pressure, required nearly 100 cubic feet of gas per B. H. P. hour, while with a compression of five atmospheres an engine of the same horse power will do the same work on 20 cubic feet of gas.

The kind of fuel governs the degree of compression, however. The compression necessary to ignite kerosene vapor, while not so volatile as gasoline, will not cause the latter to burn. Natural gas can be compressed to 150 pounds absolute,

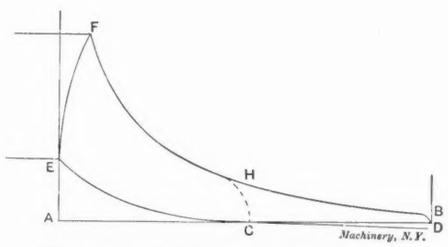


Fig. 2. Indicator Diagram for Sargent Engine.

alcohol vapor to 190 pounds, and blast furnace gas to 210 pounds, and still require an electric spark to start inflammation.

The other loss of heat in a gas engine besides that which is transmitted to the water jacket is the heat which goes out with the exhaust. When a cylinder full of gas and air is compressed and ignited, the chemical action generates an intense heat; the gases expand one-four hundred and ninetieth of their volume for every degree of Fahrenheit, and the chemical action even with a proper mixture is not instantaneous and often there is flame coming out with the exhaust.

If a full cylinder of combustible mixture is compressed from atmospheric pressure and temperature and heated further by chemical action, then when the volume is constant the pressure is increased and the release of this pressure when the exhaust valve opens causes the familiar "sea lion bark," always associated with the exhaust of a gas engine. This is the second loss of the internal combution engine, and when we consider that from 35 to 40 per cent of the heat is wasted in this way, is it any wonder that engineers have tried to minimize this loss? We all know the inefficiency of the direct acting steam pump and the gain by a more complete expansion, even though we get a lower mean effective pressure and consequently less power from the same cylinders. To utilize the heat and pressure in the exhaust, compound gas engines have been suggested, tried, and in some cases have shown an increased efficiency.

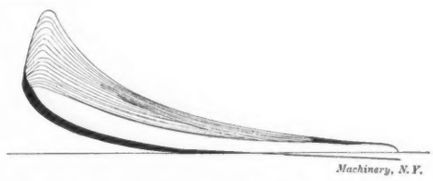


Fig. 3. Effect of Sargent Design with Variable Cut-off.

If steam were a perfect gas, void of cylinder condensation, an early cut-off in a single expansion cylinder would give as many expansions and as good economy as we get in the compound engine. The working fluid of an internal combustion engine is practically a perfect gas, therefore the efficiency of this type of prime mover may be increased if we can expand the working charge to a greater volume than is compressed.

To illustrate in a language familiar to the engineer: Fig. 1 is an indicator diagram from the ordinary Otto cycle gas engine of a popular make. In this diagram the compression is carried to 87 pounds above atmosphere, and after ignition and inflammation the pressure is released at 42 pounds above atmosphere, or 57 pounds absolute. Now, to increase the efficiency of this type of prime mover, a double-acting tandem engine was designed to give the diagram shown in Fig. 2 where *A B* represents the atmospheric line and length of stroke; with the average load the combustible mixture is drawn in at some predetermined point, *C*, where the admission is cut off and rarefied during the remainder of the stroke; the line *C D*, showing the pressure below the atmosphere. No work is lost in this rarefaction, and on the return stroke the compression above the atmosphere begins at *C*, reaching a predetermined pressure at *E; F E* is the firing line, and *F B* the expansion line, the release at *B* being slightly above atmospheric pressure. Instead of releasing at *H*, as in the ordinary gas engine, the expansion is nearly double the admission, and the area, *C H B C*, represents the increased work for the same quantity of fuel, and measures on the diagram from 22 to 25 per cent. No muffler is required and the temperature of exhaust is reduced about 1,200 deg. F. below that in the ordinary gas engine. The point of cut-off, *C*, is controlled by the governor moving toward *A* as the load gets lighter and the speed tends to increase, thereby reducing the quantity of the combustible mixture and necessarily the mean effective pressure. If the load gets heavier and the speed tends to decrease, the point *C* moves toward *B*, thereby taking in a larger quantity of the mixture, raising the mean effective pressure, and the pressure of release. If the point of cut-off, *C*, gives the highest efficiency at full load, then with an over-load or under-load, the efficiency will be decreased.

As in a steam engine, there is a limit to the degree of expansion desirable. When the pressure equals the power required to overcome the friction, a further expansion reduces the efficiency of the engine. For this reason an engine decreases in efficiency as the load gets lighter. In a single expansion steam engine it has been found that a terminal pressure of about four pounds above the atmosphere is the most efficient pressure of release while on account of the lower mechanical efficiency of the gas engine a terminal pressure of from 6 to 8 pounds seems to give the greatest economy.

In Fig. 3 is shown a diagram from this engine, with a variable load, in which the expansion line of the smallest

diagram approaches the line of highest compression, yet the highest and lowest compression lines show but little variation. The compression varies directly with an overload and must not get beyond the critical limit of self-ignition, yet the design of the engine is such that the compression only reduces one-half as fast as the cut-off, so that we maintain the highest maximum economy during the wide range of load.

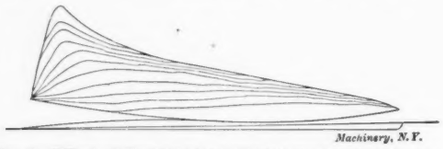


Fig. 4. Effect of Variable Cut-off with the Typical Design.

If the time of ignition is such that with a full load the firing line is vertical, or what is better, leaning about 10 deg. from the vertical, as shown in Fig. 2, as the load gets lighter, the charge is reduced by either cutting off earlier, throttling or admitting less gas, depending on the type of engine, but as the products of combustion which fill the clearance space do not decrease, the mixture gets weaker, inflammation gets slower and the piston will often travel as fast as the rise in pressure.

Fig. 4 is a variable load diagram of an ordinary throttling engine with a fixed point of ignition from which we see that as the load gets lighter the initial pressure approaches compression. As the greatest heat corresponds to the greatest pressure, we note that the cylinder surface increases so rapidly, as the piston advances in the stroke, that the flame is cooled down as fast as it is propagated. This causes a loss of efficiency which is overcome in engines advancing the time of ignition with the cut off. In Fig. 3 the highest initial pressure remains where the cooling surface is least, maintaining a much higher efficiency than with a fixed ignition. The type of engine from which these diagrams were taken is shown in Fig. 5, where the charge is expanded to a terminal pressure which gives the greatest efficiency, varies the point of cut-off with the load, and advances the time of ignition as the inflammation gets slower. The frame is inclosed and self-oiling, without the crank or disks dipping into the oil. The side shaft is driven by a Rites governor and is advanced or retarded in time ahead of the crankshaft as the load varies, maintaining a regulation within 2 per cent between full and no load. Fig. 6 represents a section through the crank shaft of this engine and shows the worm gears which drive the side shaft. The driving gear is loose on the main shaft and is advanced or retarded relative to the shaft by the governor, depending on the load. The driven gear keyed to the side shaft opens or closes the valves earlier or later, maintaining thereby a uniform speed. As these gears should run in oil to be efficient, and as the engine bearings have to be copiously lubricated, the oil flows into the spaces between the teeth and is pumped through pipes to all moving parts.

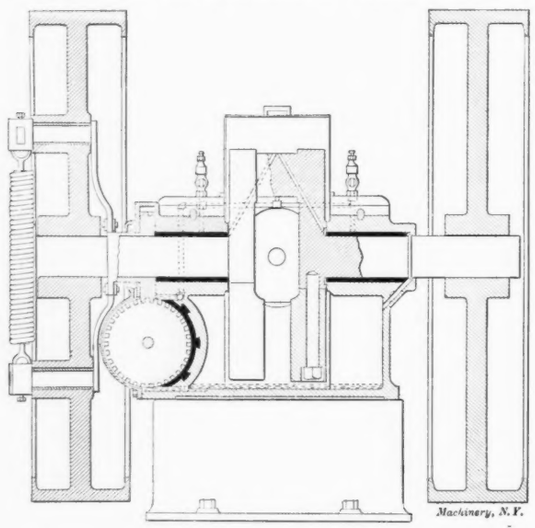


Fig 6. Cross-section of Sargent Engine.

PIPE BENDS: THEIR APPLICATION, FLEXIBILITY AND COMPARATIVE COST.

Valve World, February, 1906.

A marked feature in the piping design of a modern steam plant is the free use of bent pipe. Until very recently bends were not utilized in this country to any great extent, although in European practice they were freely employed. No doubt the high prices of fittings in Great Britain and on the Continent forced engineers to turn to bends more than was necessary in America, but this necessity made for better pipe lines, as American engineers have recently realized, with the result that bent pipe is now utilized as freely here as abroad. Bends offer many advantages to the mechanical engineer in the way of making stronger lines, reducing friction, reducing the number of joints and compensating for expansion, and contrary to general belief do not add to the cost; in fact, in many cases the cost is reduced. Some of the more common forms of pipe bends and their application to steam lines are shown in the following cuts.

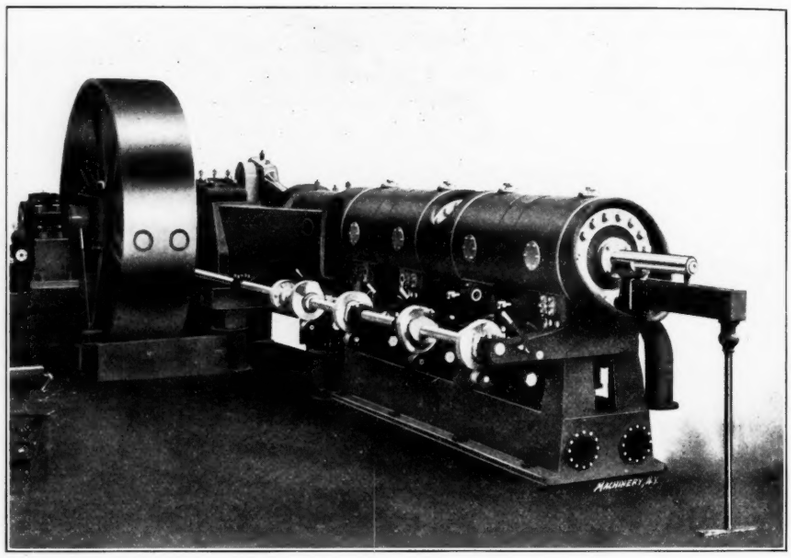


Fig. 5. Sargent Double-acting Gas Engine.

So far as can be ascertained, no thorough attempt has ever been made to determine the maximum amount of expansion which a U-loop, or quarter bend, would take up in a straight run of pipe having both ends anchored. Experiments in this direction would have to cover a wide range of sizes and materials, for flexibility increases with the radius and decreases with the diameter. It is also greater with full weight than extra strong pipe. The practical limit would also be governed by the strength of the material in the flanges or fittings to which the bends were bolted.

As far as the radii of pipe bends are concerned, local conditions in the average power plant prevent extremes in the way of very long bends. The Crane Co. have adopted five diameters of the pipe as a standard radius, which come nearer than any other to suiting average requirements, and at the same time produce a symmetrical article. Bends shorter than this can be made, but they are extremely stiff, tend to buckle in bending, and the metal in the outer wall is stretched beyond a desirable point. Very short bends must be made of extra strong pipe if a safe thickness of metal is to be maintained, and when it is necessary to use the minimum radius

to which extra strong pipe can be bent, such bends should be considered as fittings only, and not taken into account when making provision for expansion.

During the summer of 1905 the Crane Co. made a few experiments with 8-inch U and quarter bends to ascertain the amount of expansion they would take up. For the first test a run of 8-inch pipe, as shown in Fig. 14, was bolted together. The bend was made of steel pipe 0.32 inch thick, weighing 28 pounds per foot, with extra heavy cast-iron flanges screwed on and refaced. The elbows were extra heavy cast-iron, and the straight pipe was steel with extra heavy cast-iron flanges screwed on and refaced. The pipe was laid on rollers and anchored at points *AA* with indicators to detect any movement which might take place at points of anchorage.

Test No. 1.—After the line had been under steam about five minutes and the gages indicated 80 pounds pressure, one of the pipe flanges *B* broke on the north end, one length away from the elbow. The total expansion was 1⅞ inches at the time the break took place. The reason for the break was the lifting of the pipe, near the U bend, off the rollers, which would naturally throw a severe strain upon the line flanges. Outside temperature, 72 degrees.

Test No. 2.—This test was made on the same line. At 50 pounds pressure the line expanded on the short end ⅞ inch and on the long end 1⅛ inches; total, 2 inches. At 100 pounds pressure the expansion was 1 3-16 inches on the short end, 1½ inches on the long end; total, 2 11-16 inches. At 150 pounds pressure the short end expanded 1⅛ inches and the long end 1⅞ inches; total, 3 inches. At 200 pounds pressure the short end expanded 1½ inches and the long end 1⅞ inches; total, 3⅜ inches. At 208 pounds pressure the line flange *B* again broke, due to the lifting of the line near the bend. As nearly as could be determined, the maximum amount of this lift at the elbows was 1¼ inches. There was no slippage at the anchors and the whole expansion of 3⅜ inches was taken up by the bend. Outside temperature, 78 degrees.

Test No. 3.—Before removing the 8-inch U bend from the line a test was made to ascertain whether a bend of this kind would have a tendency to spread if the anchors were removed. The anchors were taken away and steam was turned in at 200 pounds pressure. The bend spread ⅜ inch, which was about the natural expansion due to the temperature.

After removing the U-bend a quarter bend was put in at one end of the line, in the manner shown in Fig. 15. The line was rigidly anchored at points *AA*, and held at point *B* in such a manner that the pipe could not lift or move laterally. The bend was made of full weight steel pipe 0.32 thick, with extra heavy cast-iron flanges screwed on and refaced. The line flanges and fittings were also extra heavy cast-iron.

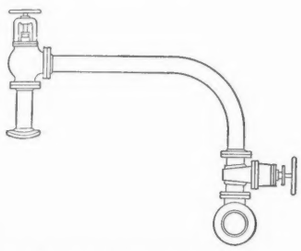


Fig. 1- Boiler and header connection

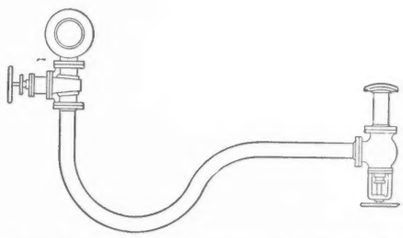


Fig. 2- Boiler and header connection when header is higher than in Fig. 1

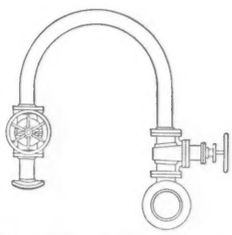


Fig. 3- Boiler and header connection with a U-bend

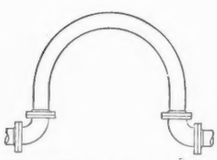


Fig. 4- U-bend located in a straight run to allow for expansion

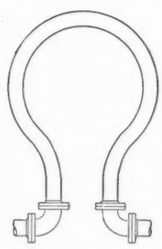


Fig. 5- Modification of Fig. 4 for limited center to center spaces

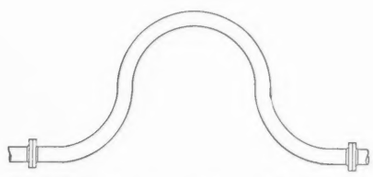


Fig. 6- Expansion loop in straight line. If made in a single piece, can be used only in 8-inch or smaller sizes.

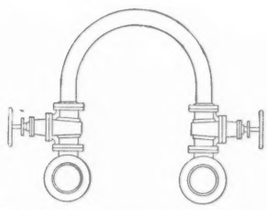


Fig. 7- U bend cross-connecting two parallel headers

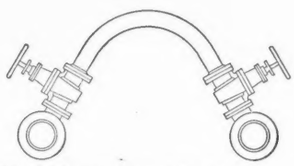


Fig. 8- Modification of Fig. 7 for special conditions. This form entails some loss in flexibility.

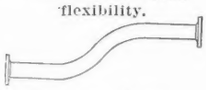


Fig. 12- Offset bend

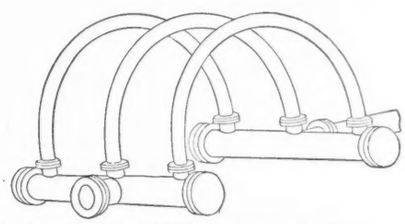


Fig. 9- Battery of three 8-inch U bends connected to headers and placed in 14 inch main steam line to take care of expansion and contraction. This combination is preferable to a U-bend the full size of the pipe, because of its greater flexibility.

Fig. 10- Compound quarter bend to suit local conditions

Fig. 11- 45 bend

Fig. 13- Crossover bend. Used when necessary to avoid other pipes, pillars, etc.

Machinery N.Y.

Examples of Pipe Bends, with General and Special Applications.

Test No. 4.—*Full Weight Quarter Bend.*—Steam was turned into the line and when the gage indicated 80 pounds and the line had expanded 1⅜ inches, the joint at flange *C* commenced to leak, the lower part of the flange being forced back slightly on the pipe. This was a remarkable result, and it is difficult to account for the flange not breaking.

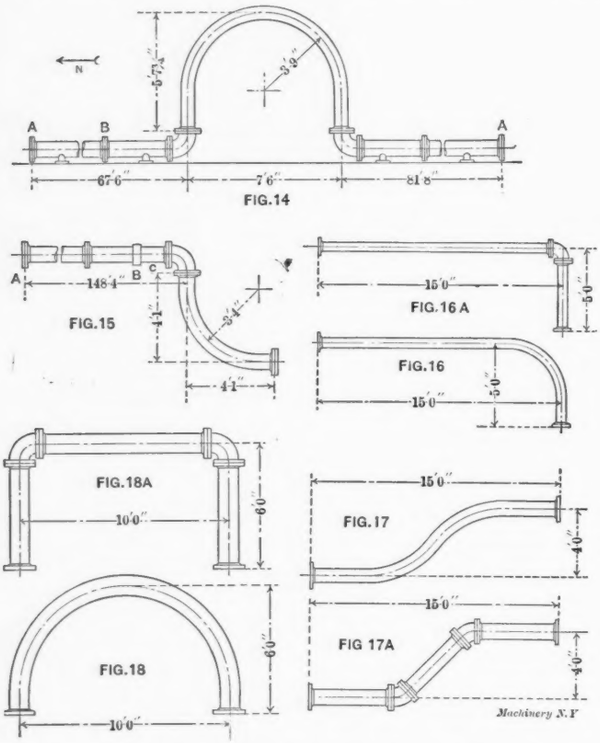
Test No. 5.—*Extra Heavy Quarter Bend.*—The full weight quarter bend was removed and an extra heavy bend of the same dimensions substituted, all other conditions remaining the same. Steam was turned on, and when the line had expanded ⅞ inch, flange *C* broke at the top. A new flange was put on, and when the expansion was 1⅛ inches the same flange broke at the bottom.

Further investigation along this line had to be abandoned for the time, as the space taken up was urgently needed. These few experiments were confined to bends having a radius of five diameters with short tangents. It is reasonable to

suppose that longer radii and tangents would make for greater flexibility.

As an illustration of the comparative cost of full-weight bends and straight pipe and fittings, take a 6-inch connection like that in Fig. 16. The value of a 6-inch full-weight quarter bend as shown, with extra heavy cast-iron flanges, and two sets of bolts and gaskets, is approximately $23.50, while the two pieces of pipe, elbow, flanges, and labor, as shown in Fig. 16A, with four sets of bolts and gaskets, would be about $26.

Or, take a 10-inch offset bend, made of full-weight pipe, with extra heavy flanges, as in Fig. 17. The cost of the



Arrangement for Testing Flexibility of U-bends, and Comparison of Bends and Fittings.

bend, with two sets of bolts and gaskets, is about $57. The pipe and extra heavy fittings, Fig. 17A, with six sets of bolts and gaskets, would be worth about $76.

An 8-inch U-bend with extra heavy flanges, as illustrated in Fig. 18, is worth about $41 with bolts and gaskets. Fig. 18A, with extra heavy fittings, bolts and gaskets, costs approximately $57.

A properly finished bend should bolt in place without strain. If it is necessary to force it into position there will always be a great strain upon the bolts and flanges, the joints will probably leak, and the benefits to be derived through the use of the bend will be partially destroyed.

* * *

MAKING STANDARD SCREW THREADS.—2.

The "Acme" thread is a modification of the square thread, designed to do away with some of the difficulties tending the construction of the older form. The principal objection to the square thread is the necessity for smoothing up the sides of the groove after it has been cut to the full depth. The sides are always left rough and are often scored by the digging in of the corner of the tool, since these surfaces are formed entirely by this corner and not by a shaving cut from a straight cutting edge. To overcome this difficulty it has become customary, while retaining the general dimensions of the square thread, to incline the sides of the tool at an angle of 29 degrees with each other, thus providing for a progressive shaving of the sides of the groove as the tool nears the bottom of the cut.

The working depth of the Acme thread is made the same as for the square thread. That is to say, the working depth

$$= \frac{1}{2 \times \text{the number of threads per inch.}}$$

To this amount, however, is added 0.010 inch at the bottom of the groove for clearance, thus making the total depth of the thread $= \frac{1}{2 \times \text{number of threads per inch}} + 0.010$. At what may be called the pitch line, at one-half the working depth of the thread, the width of the tool is the same as that of the square thread, being equal to the working depth. The inclination of the sides, however, gives different values to the width at the top of the thread and the width at the point of the tool. Of these the width at the point of the tool is narrower on account of the added clearance and is equal to $\frac{0.3707}{\text{number of threads per inch}} - 0.0052$. This formula holds true for a screw or tap thread. The width of a screw or nut thread at the top $= \frac{0.3707}{\text{number of threads per inch}}$. In cutting a tap the diameter must be made 0.020 inch greater than that of the screw to be used in the hole tapped, this allowance being made for the 0.010 inch clearance which the tap cuts on each side. This added diameter makes the width at the top of the thread equal to the width of the thread tool with which the tap is cut.

A table is also given for worm thread tools, and tools for British standard threads. It might be mentioned in connection with these tables, and those which appeared in the data sheet sent with the March issue, that dimension *A* gives the amount to be added to the readings given by a Brown & Sharpe thread micrometer to get the outside diameter. This refers, of course, only to the forms of thread for which the micrometer is adapted.

* * *

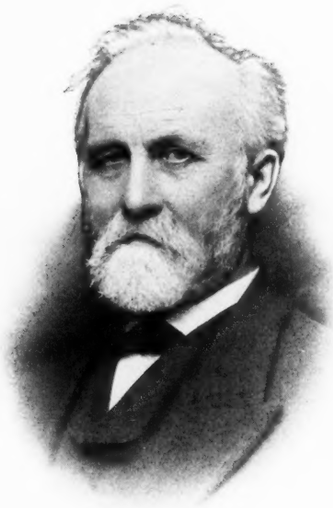
THE ANTI-METRIC CHAMPIONS.

An informal dinner was given at the Waldorf-Astoria on March 31 by a committee representing manufacturers in many lines of business, to Frederick A. Halsey of the *American Machinist* and Samuel S. Dale, of the *Textile World Record* in recognition of their efforts in behalf of the established standards of measurement and in opposition to the introduction of the metric system in this country. A considerable sum of money was originally collected for presentation to Messrs. Halsey and Dale; but those gentlemen were much too modest to accept any compensation for their work, and suggested that the fund should be used to advance the cause by circulating and endowing their book "The Metric Fallacy." This plan was accordingly carried out and a copy sent to every member of Congress.

There were present at the testimonial dinner, besides the guests and committee (with the exception of Mr. Sharpe, who is abroad, and Mr. Durban, who was unable to attend on account of sickness) the editors and publishers of several trade papers identified with the interests affected by the contemplated change. The subject was very thoroughly gone over by various speakers, and plans for continuing the fight were considered. Messrs. Halsey and Dale were each presented with a cathedral chime hall clock from the funds collected by the committee, which consisted of Mr. Henry D. Sharpe, Brown & Sharpe Mfg. Co.; H. M. Covell, of the Lidgerwood Mfg. Co.; William Lodge, of Lodge & Shipley Machine Tool Co.; Thomas E. Durban, Erie City Iron Works, and Mr. J. H. Schwacke, William Sellers & Co., Inc., chairman.

* * *

The students taking a mechanical course in Sibley College, Cornell University, are required to do a certain number of hours work each year. The time clock checking system is employed, each student being required to check in and check out, the same as if he were working in a regular manufacturing plant. The scheme not only gives an autographic record of the attendance of the student, but also introduces him to one of the features of real shop life which he will afterwards experience, if he enters the mechanical field where he should, that is, at the bottom.



JOHN E. SWEET.

REPRESENTATIVE AMERICAN MECHANICS.

John E. Sweet was born at Pompey, New York, in 1832. His boyhood was spent on his father's farm and was given up to the varied work that a farmer's boy is called upon to do and to securing a common school education at the local schools of his native town. His mother was an Avery—a name associated with some of the early and noteworthy mechanical work of the country. The Avery family numbered among its members many able mechanics, among them the Avery who patented the first American steam turbine, which was one of the earliest turbines in the world to be put to any practical use. In 1835 several of these were in operation, one being used to drive a saw-mill at Syracuse, N. Y. It is probable, therefore, that young Sweet was by inheritance destined to become a machinist and engineer; and this in spite of his early training, which was in quite a different sphere. That he had a mechanical bent was early evident, one of his achievements as a boy being the construction of a violin, which so pleased his parents that he had the distinction of being sent to take violin lessons—a very unusual event at that time for a farmer lad.

At the age of 18 he was apprenticed to learn the carpenter's and joiner's trade and his time was devoted to carpentry and building until nearly 30 years of age. After completing his apprenticeship he secured a position in the first architect's office opened in Syracuse conducted by Elijah T. Hayden, where he had an opportunity to become familiar with drawings of framed structures and building details. The laying out of such details passed for "architecture" in those days, since the artistic side of building design had not then received much attention, particularly in the smaller towns and cities.

The building plans of Sweet, the architect, bore the stamp of originality that has so characterized his later work. One of his most successful efforts, from a utilitarian point of view, was a set of plans for a model farm barn; and so great was the call for these that they were several times published in the *Rural New Yorker* and led to a series of articles in this publication by the young architect. This was the beginning of Prof. Sweet's work as an author and since those days manuscript from his pen has been eagerly sought by technical as well as popular journals and papers; for his writing has always been bright and original, frequently suggesting new ideas and leading the reader along the paths of original thought.

His last work as an architect was in connection with the building of a hotel in Alabama, which was in process of construction at the outbreak of the Civil War. In common with many Northerners then in the South he came North with the opening of hostilities. Later he went abroad, traveling in England and on the Continent, the immediate reason for his trip being the famous London Exposition of 1862. While abroad he contributed a series of letters to a Syracuse paper, showing him to be a versatile writer along popular as well as technical lines.

Singularly enough the beginning of his mechanical career was made in England. He secured a patent on a nail machine in which the Patent Nut & Bolt Co., of Birmingham, England, took an interest so that he went there and entered their employ while superintending the making of his machines. While there he began writing upon technical subjects, contributing to London *Engineering*.

His mechanical career in America began in 1864 when he was employed by the firm of Sweet, Barnes & Co., of Syracuse, as draftsman. He was here engaged upon a varied line of machines, one of which was a matrix-impressing machine arranged with a keyboard and aiming to do away with the use of movable type. This machine was really a progenitor of the present linotype machine and the first and only one constructed was exhibited at the Paris Exposition of 1867 and later presented to Cornell University, where it now is.

In the early seventies Mr. Sweet's efforts were extended in still another field—that of bridge building. At about this time, however, he had conceived the idea of his Straight Line engine which is inseparably connected with his name and is perhaps his most characteristic piece of work. The features of the engine are too well known to require extended description. Nearly every feature of the engine was different from what had been done before. The straight lines of the frame, the oiling arrangement, the governor, the arrangement and location of the flywheel, the substitution of a plain sleeve for piston rod packing, etc., as well as other features, have been much discussed and have influenced machine design in general.

Prof. Sweet's connection with Cornell University began in 1873 and terminated in 1879. One of the first college machine shops in the country was established at this institution, and Prof. Sweet gave instructions both in shop work and in machine design. The second Straight Line engine built was made by students in this college shop and exhibited at the Centennial Exposition. The Sweet measuring machine was developed while he was at Cornell and was the first machine for accurate measuring made in this country. He introduced into the Sibley shop the making of scraped surface plates and straight edges, and of ground standard gages, at a time when such auxiliaries to shop processes were considered unnecessary refinements. Another of his Cornell products was the Sweet engine lathe, having a cone of change gears located in the head stock beneath the main cone of the lathe and so connected that any feed or thread could be obtained without putting on or taking off change gears as in the ordinary type of lathe. Another feature of this lathe was the support of the bed upon three points, a principle that he had adopted, also, in the Straight Line engine frame.

In an article contributed to the *Sibley Journal of Engineering* by Prof. Albert W. Smith, Director of Sibley College and a former student of Prof Sweet, are appreciative words concerning the latter's work. He says, "Prof. Sweet was an 'intuitive designer.' The rest of us struggle with mathematical intricacies toward uncertain results, while he sees the end at first and wonders that we do not. A mathematician once asked him about something that he had proved by pages of equations. Professor said: 'Suppose this and that, then the proposition is true, isn't it?' And it was true. But what are we going to do with our mathematics if things are to be done this way?

"In the 'old days' the shop—there was but one—was in the first floor room in the west end of Sibley. One could go there any day and find Professor Sweet whittling a pattern or scraping a surface-plate—for he always had work for his own hands—with a group of students standing around listening to a lecture that was not on the schedule. These lectures were among the best of our course. Or it would be an informal discussion. Some student had found an interesting unsolved question, and each student present would express his opinion and the fog would thicken till the question was entirely hidden. Then Professor would smile and shift the switch and turn clear light on the whole subject, and we would go away wondering how we had failed to see anything so simple.

"It would be natural that sound judgment should accompany Prof. Sweet's other straightforward qualities. Once an inventor of the tangle-brain type showed him an invention of great ingenuity and complexity. Then he asked him what he thought of it. 'Well,' said he, 'it seems to be a mighty good way to do a thing that doesn't need to be done.'

"Prof. Sweet's influence on his associates is strong because of his personal qualities. His keen sense of humor makes it a rare privilege to hear him tell a story or to tell him one. His kindness and ready sympathy make it a rare privilege to have him for a friend."

Shortly after his resignation from Sibley College, the Straight Line Engine Co. was organized at Syracuse, with Prof. Sweet as president and manager and the conduct of this business has been his work for the past twenty-five years. In the building and equipment of this plant his originality was manifest, as always. It was one of the first saw-tooth roof shops to be erected in this country and among the tools was a planer-type milling machine, then not a common machine in America, designed by him and built at the Straight Line Engine Co.'s works.

From time to time he has contributed to American technical publications, and it has not been uncommon for his articles to draw out a stirring discussion and quite likely with him taking, what has seemed to many to be the unpopular side. He has had no sympathy with the typical American idea of claiming everything for this country and seeing no good in the work of our friends across the water. While a true American himself, he has always been ready to acknowledge the worth of achievements of mechanics in other countries, and has openly expressed his approval of many of their mechanical designs and methods and has not hesitated to call attention to such features as he believed to be superior to the work of American mechanics.

Prof. Sweet was one of the founders of the American Society of Mechanical Engineers, was elected its third president and wrote the first paper presented before the society in recognition of his untiring services during its organization. He was also, later, elected an honorary member of the society. He is one of the members who is sure to become the center of a group of friends at the social meetings of the society when stories are told and experiences are related. A pleasant event was the presentation to the American Society of Mechanical Engineers of an oil painting of Prof. Sweet two years ago, which now hangs in the lecture room at the New York headquarters.

Prof. Sweet was one of the judges on machine tools at the Chicago Exposition; an expert for the government on gun lathes; and one of the founders and first president of the Engine Builders' Association of the United States. He has been president of the John Fritz Medal Association, one of the founders and first president of the Technology Club, and president of the Metal Trades Association of Syracuse.

One of the ambitions of Prof. Sweet has been the establishment of a trade school where young men can be instructed in the mechanical arts in a way to fit them to become mechanics. This ambition, it appears, is likely to be realized, as about one-half of the required capital stock of $50,000 has been pledged by various manufacturers of that city. The prospectus issued by the committees reviews the conditions that manufacturers are feeling more and more, there being a lack of well-trained machinists and other skilled mechanics necessary in every shop. It states that the object of the school is to provide a shop in which young men may learn the art and acquire the handicraft necessary to meet the requirements of the modern shop. It is proposed to first organize a shop school fully equipped with machine tools with the necessary drafting, study and lecture rooms attached. The instructors will be men of practical experience like Prof. Sweet, who proposes to give half of his time to the school. It is planned to operate the shop school on a commercial basis, meaning by this that the shop will make articles that can be sold in the open market in competition with regular commercial shops.

* * *

A common circumferential speed for a circular saw is 10,000 feet per minute.

TESTS FOR FAULTS IN ARMATURES.

NORMAN G. MEADE.

It is very desirable to be able to locate faults in motor or generator armatures around shops with simple apparatus that may be on hand. A method which has proven very reliable and requires only a few cells of battery and a telephone receiver is given below.

Test for Open Circuit. Clean the brushes and commutator, and apply current from a few cells of battery having a telephone receiver in circuit as shown in Fig. 1. If the machine has more than two brushes, connect the leads to two adjoining brushes and raise the balance. Now rotate the armature slowly by hand and there will be a distinct click in the receiver as each segment passes under the brushes until one brush bears on the segment at fault, when the clicking will cease. Note that the brushes must not cover more than a single segment.

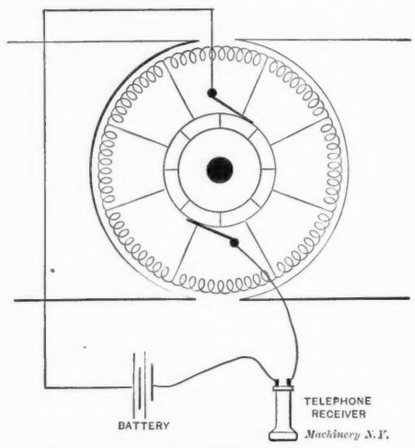


Fig. 1. Test for Break in Armature Lead.

If, on rotating the armature completely around, the receiver indicates no break in the leads, connect the battery leads directly to the brushes, as shown in Fig. 2, and touch the connections from the receiver to two adjacent bars, working from bar to bar. The clicking should be substantially the same between any two commutator bars; if the clicking suddenly rises in tone between two bars, it is indicative of a high resistance in the coil or a break (open circuit).

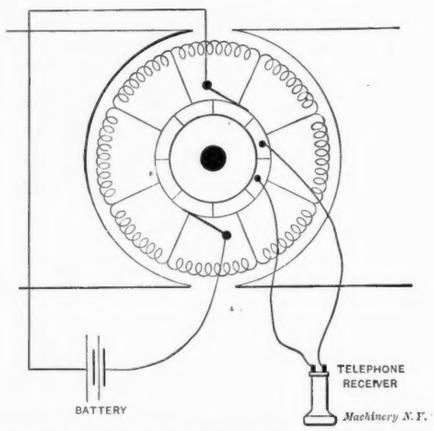


Fig. 2. Bar to Bar Test for Open Circuit in Coil or Short Circuit in one Coil or between Segments.

Test for Short Circuit. Where two adjacent commutator bars are in contact, or a coil between two segments becomes short-circuited, the bar to bar test just described will detect the fault by the telephone receiver remaining silent. If a short circuit is found the leads from the receiver should then include or straddle three commutator bars, as shown in Fig. 3. The normal click will then be twice that between two segments until the coils in fault are reached, when the clicking will be less. When this happens, test each coil for trouble and, if individually they are all right, the trouble is between the two.

Test for Grounded Armature. Place one terminal of the receiver on the shaft or frame of the machine, and the other on the commutator. If there is a click it indicates a ground.

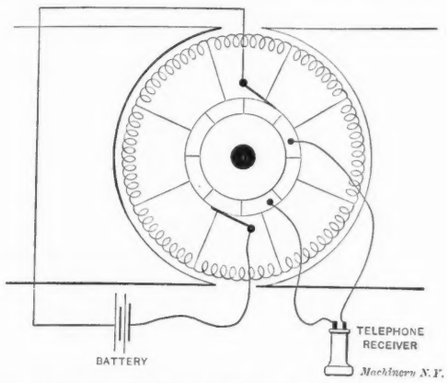


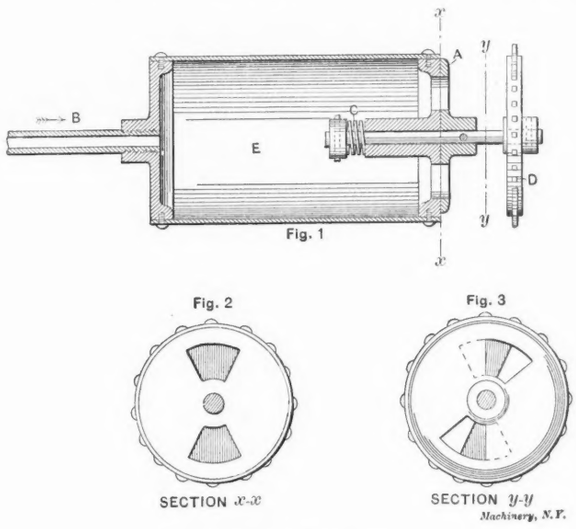
Fig. 3. Alternate Bar Test for Short Circuit between Sections.

Move the terminal about the commutator until the least clicking is heard and at or near that point will be found the contact. Grounds in field coils can be located in the same manner.

* * *

WEISS EXHAUST MUFFLER FOR GAS ENGINES

The sharp, gun-shot-like explosion of the gasoline engine is ordinarily muffled on the automobile by some combination of baffle plates which break up and retard the outflowing gases so that the explosive effect on the atmosphere is largely overcome. Unfortunately, these mufflers, in general, introduce considerable back-pressure and if they become clogged with carbon, as they are very likely to do, the back-pressure may become so high as to seriously retard the action of the engine



Exhaust Muffler for Gas Engines.

and reduce its power. This is well recognized by automobilists, and in all road races the mufflers are removed so that the engines exhaust directly to the atmosphere. This is the reason for the sharp exhaust characteristic of the high-speed machines in such events.

The accompanying cut shows an exhaust muffler for gas engines which was designed to effectually prevent the noise of the exhaust without introducing much back-pressure. It is the invention of Louis T. Weiss, of Brooklyn, N. Y., and was applied by him to a Winton machine which had given considerable trouble because the regular muffler soon became clogged with carbon to such an extent that the power of the engine was greatly reduced. The construction of the device is simple, but its effect upon the exhaust is not apparent without some explanation. The exhaust from the cylinder is admitted through *B* to an expansion chamber *E*, Fig. 1, which at the time of the exhaust release, is closed. But, before the piston has traveled more than a small fraction of an inch on the upward stroke the rotary valve shown at *A* is opened, allowing the exhaust to escape freely to the atmosphere. The valve *A* is mounted on a shaft on which is a sprocket wheel, *D*. This latter is connected with a chain to the crankshaft of the engine and is timed so as to open as indicated in the foregoing. The explanation of the muffling action is simply that the explosive effect of the exhaust is reduced by its escape into the expansion chamber, which is about five times as large as the cylinder volume, and also because of the cooling effect. The chamber *E* acts in a measure as a condenser and by the time the rotary valve has opened the gases have cooled to such an appreciable extent that, with the reduction of pressure due to the greater volume, there is not the sudden sharp explosive effect that takes place when the exhaust valve is opened directly to the incandescent gases in the cylinder. To avoid danger of over-pressure in chamber *E* in case that the timing arrangement should fail, the sprocket shaft is provided with a collar at its inner end, and between this collar and the hub of the chamber head is a coiled spring; in case of over-pressure the rotary valve is lifted from its seat, by compressing the spring, which allows the gases to escape.

It is claimed that the reduction of back-pressure made possible with this muffler makes a surprising difference in the power of the average automobile engine and also permits the use of less battery power because the mixture will be uniformly richer. This, of course, results because of the freer exhaust and the consequent greater discharge of the exhaust gases from the cylinder. In case of considerable back-pressure the volume of exhaust gases left in the clearance space of the cylinder is sufficient to expand and considerably reduce the quantity of the incoming charge, thus making it so poor a mixture that a very strong spark may be required to fire it.

* * *

THOMAS RICHARD ALMOND.

Thomas R. Almond died at his home in Dunwoodie Heights, Yonkers, on March 31, 1906, following a six days' illness from pneumonia.

Mr. Almond was born in Uppingham, Rocklandshire, England, in 1846. He came of Norman stock, his ancestors having

Thomas R. Almond.

settled near his birthplace as far back as the Conquest. He early displayed remarkable inventive mechanical ability and at the age of twelve was awarded a special prize at a London exhibition for a model working steam engine involving an original and meritorious valve gear. He came to America in 1866, establishing himself as a machinist in Fitchburg, Mass., where he later married Eleanor Hortense Tollman, daughter of Cyrus Stone Tollman. The business was removed to Brooklyn in 1875, and has since grown to large proportions, developing engineering specialties under the Almond patents.

Mr. Almond was a versatile inventor, his numerous patents covering many fields. Those which have been commercially successful include the Almond chuck, the Almond portable

stove lamp, the Almond angular shaft coupling, the Almond turret head tool, and the Almond flexible metallic tubing. Two years ago, having relinquished control of his business, Mr. Almond then devoted his time to the development and perfection of a highly original and simple reaction steam engine which was nearly perfected at the time of his death. An unprecedented honor was his in being twice the recipient of the annual John Scott metal awarded by the Franklin Institute of Philadelphia for meritorious invention.

He was a member of the Canadian Club, the Scarsdale County Club, the Dunwoodie County Club, an enthusiastic officer of the Yonkers Choral Union, a member of the American Association for the Advancement of Science, and a life member of the American Society of Mechanical Engineers, in which he took an active interest and whose transactions have been enriched by his papers and discussions.

* * *

THE BURBANK QUICK CHANGE GEAR.

An interesting change gear mechanism has been invented, designed and patented by Louis S. Burbank, formerly of Worcester, Mass., and now of Phoenix, Md. This device has been carefully worked out, to the extent of redesigning seven or eight times, and two complete mechanisms, including the lathes to go with them, have been built by the F. E. Reed Co., Worcester, Mass., who have recently purchased a shop right for the use of the mechanism.

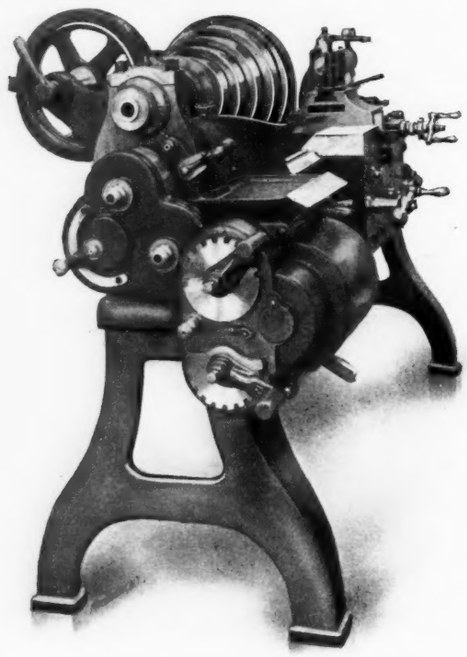


Fig 1. Reed Lathe Equipped with Burbank Change Gear Device.

In the Burbank device, the gear cone is held on a separate and "floating" shaft, with nothing else on the shaft but the cone of gears. Two gears which drive to and from the cone are constructed to slide back and forth on their respective quill shafts the full length of the cone; and are placed just far enough apart to allow them to pass each other. By this construction, either sliding gear will drive with any one of the cone gears independently of the other.

The term "floating cone" gives a first impression of instability; yet this method of securing this floating shaft is one of the features of the device. Each end is held in position by two links, which reach by straight lines from two quill shafts to the cone shaft, thus forming a triangle of links—the well known bridge construction principle. Within either quill shaft is a smaller rocking shaft, having a pinion near each end, one for each link, and having also a handle at the outer end to manipulate the links by. The pinions mesh into racks on the links, so that the manipulation of the upper and lower rocking shafts throws in or out the upper or lower pair of links, thus permitting any of the gears of the floating cone to be brought into mesh with either of the sliding gears. The photographs show a Reed lathe equipped with the device.

The details of the mechanism can be more fully explained by aid of the lettered and figured engravings, Figs. 2 and 3. In these 2 is the cone shaft supported by links *A* and *B*, and 1 and 3 are the quill shafts previously referred to. The mechanism is driven through the gear *a* fast to the quill on shaft 1 and motion is transmitted through the several gears as follows: From sliding gear *b* on the upper quill to the cone gear with which it is in mesh, as *c*; and from one of the cone gears, as *d*, to sliding gear *e* on the lower quill.

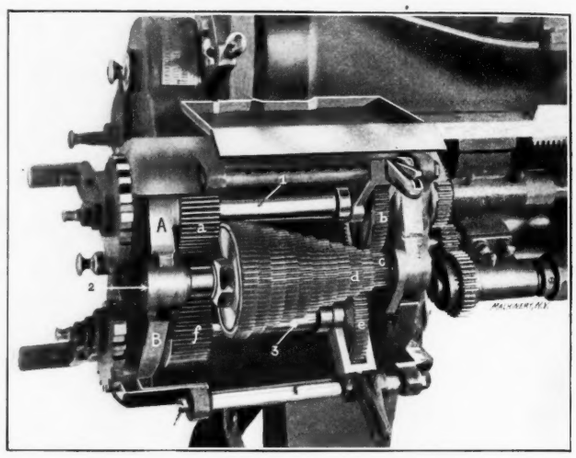


Fig. 2. Gear Case Cover Removed showing Arrangement of Gears.

Gear *g* on shaft 4 is driven by gear *f* on the lower quill and transmits motion to the lead screw or the feed rod as the case may be. The adjustment of links *A* and *B* is by means of the pinions on shafts 1 and 3 which mesh in racks cut in these links, as previously explained.

In connection with this speed box is an end combination of gears shown in Fig. 4 which has a two-gear cone and two sliding gears that are adjusted in much the same manner as the gears in the main part of the mechanism. The end combination, having two gears which are in the ratio of 2 to 1, gives three speeds, the extremes of which are in the ratio of 4 to 1. As the casing for the end combination is only two gears wide it is very compact in its arrangement.

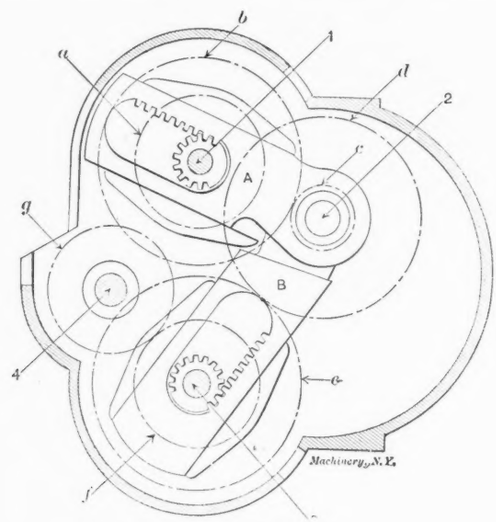


Fig. 3. Diagram of Gearing.

The list for cutting threads is arranged in a unique way to facilitate the greatest convenience in setting. For instance, only the threads ordinarily used, namely, from 4 to 26, appear at all on the list, thus simplifying the use of the device and it might here be added that all of these most ordinary threads are obtained *without* employing the end combination. As the end combination serves simply to multiply or divide these threads by two, the total range of threads is from one-half of 4 to twice 26; that is, from 2 to 52, and by a special position,

the finest threads are increased to 60, making 33 threads in all; but these are not all that can be cut on the device, as will be seen later.

The handles which operate the upper and lower sliding gears, above referred to, slide on rods which have notches in them to stop the handles opposite the several cone gears. The lower notch rod has for the normal threads, only two notches in it, for the sliding gear serves, in its right hand position, in a sense, as an end combination to multiply all the threads on the upper row of the thread list. But by rotating this lower

PARTIAL LIST OF SPECIAL THREADS.

(The complete Table contains 174 different Threads.)

Columns 1 indicate Threads per inch expressed in Decimal Fractions.
Columns 2 indicate Threads per inch expressed in Common Fractions.

1	2	1	2	1	2	1	2
1.449	.....	5.385	$5\frac{5}{13}$	9.857	$9\frac{6}{7}$	18.333	$18\frac{1}{3}$
1.538	$1\frac{7}{13}$	5.417	$5\frac{5}{12}$	10.145	.....	18.461	$18\frac{6}{13}$
1.666	$1\frac{2}{3}$	5.455	$5\frac{5}{11}$	10.616	.....	18.572	$18\frac{4}{7}$
1.812	.....	5.555	$5\frac{5}{9}$	10.769	$10\frac{10}{13}$	18.841	.....
1.818	$1\frac{9}{11}$	4.625	$5\frac{5}{8}$	10.833	$10\frac{5}{6}$	19.717	. .
1.923	$1\frac{12}{13}$	5.714	$5\frac{5}{7}$	10.909	$10\frac{10}{11}$	21.231	$21\frac{3}{13}$
2.083	$2\frac{1}{12}$	5.75	$5\frac{3}{4}$	11.111	$11\frac{1}{9}$	21.666	$21\frac{2}{3}$
2.174	..	5.797	.....	11.25	$11\frac{1}{4}$	21.818	$21\frac{9}{11}$
2.222	$2\frac{2}{9}$	5.833	$5\frac{5}{6}$	11.428	$11\frac{3}{7}$	22.222	$22\frac{2}{9}$
2.273	$2\frac{3}{11}$	5.909	$5\frac{10}{11}$	11.5	$11\frac{1}{2}$	22.5	$22\frac{1}{2}$
2.308	$2\frac{3}{13}$	6.111	$6\frac{1}{9}$	11.6	.....	22.857	$22\frac{6}{7}$
2.536	.....	6.154	$6\frac{2}{13}$	11.666	$11\frac{2}{3}$	23.0	23
2.692	$2\frac{9}{13}$	6.25	$6\frac{1}{4}$	11.818	$11\frac{9}{11}$	23.333	$23\frac{1}{3}$
2.727	$2\frac{8}{11}$	6.272	$6\frac{3}{11}$	12.222	$12\frac{2}{9}$	26.637	$23\frac{7}{11}$
2.778	$2\frac{7}{9}$	6.364	$6\frac{4}{11}$	12.308	$12\frac{4}{13}$	24.444	$24\frac{4}{9}$
2.857	$2\frac{6}{7}$	6.428	$6\frac{3}{7}$	12.5	$12\frac{1}{2}$	25.0	25

notch rod, a large range of special threads, 174 in number, can be brought into instant use. Thus, in this special position of the lower notch rod, the number of threads obtainable is equal to those that could be cut if the gears of the cone were all loose, as in the old way, and used in all possible combinations.

These special threads are useful in many ways as in cutting worms, etc., and like a good many other new things, are not

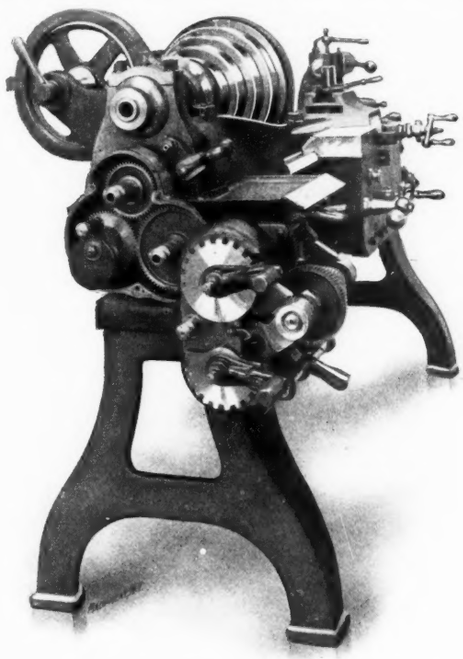


Fig. 4. Gear Case Covers Removed, showing Gears of Feed Box and End Combination.

fully appreciated until they are tried. For instance, suppose it was desirable to match a worm to a gear which was cut to an 8 diametral pitch; the threads per linear inch on the worm would be $8 \div 3.1416$, which equals 2.54, approximately. (In the table herewith are listed a few of the 174 special threads to be obtained. The first column gives the threads per inch expressed in decimal fractions and the second column the corresponding common fractions. As ordinarily arranged the table also indicates the positions of the handles for the different threads, but these are omitted in order to save room.) Looking on this table we find the pitch 2.536, which is close enough to the above 2.54 for all practical purposes. Or, again, 9 diametral pitch would require 2.86, and the table gives 2.857, very close indeed. Or, again, a 10 pitch would require 3.18, and the table gives 3.182, etc., so that in case a special thread is required, one does not have to figure at all, but simply finds if the desired thread is on the list, and if so, set it on the lathe as quickly as any other thread. This flexibility is not had at the expense of simplicity, but is in the nature of the mechanism.

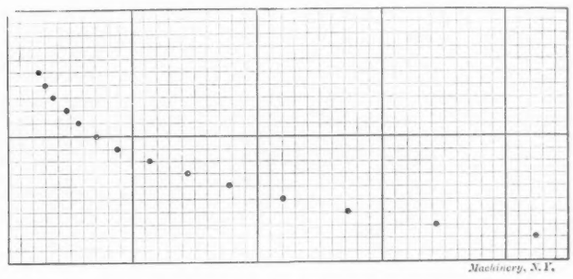


Fig. 5. Diagram showing regularity of Speed Increments with Three-gear Device.

This device is also designed to give table feeds in a convenient way. Pushing in the knob at the left, throws the threads out of commission and the feeds in; then the same thread list on the lathe is used, and the range on the top row alone gives all the feeds ordinarily used. Any lighter or heavier cuts can of course be had by manipulating the lower handle and the end combination.

Another convenient feature of the device is that the actual cut per inch of work on the lathe can be known at any time by simply multiplying the indicated thread by 8; thus if the lathe is set to table feeds, and the position indicates 5 threads per inch, the cut is 5 times 8, or 40 per inch, etc. The speeds may be, therefore, designated by the numbers representing the various threads per inch, or they may be specified in the usual way and readily set on the lathe. For instance, work is specified to feed 30 cuts per inch; 30 divided by 8 equals 4 approximately. Therefore, set the handles at the position to cut 4 threads per inch, and run the carriage on the table feeds instead of threads. This eight is thus seen to be a very convenient figure to convert the threads to table feeds, and *vice versa.*

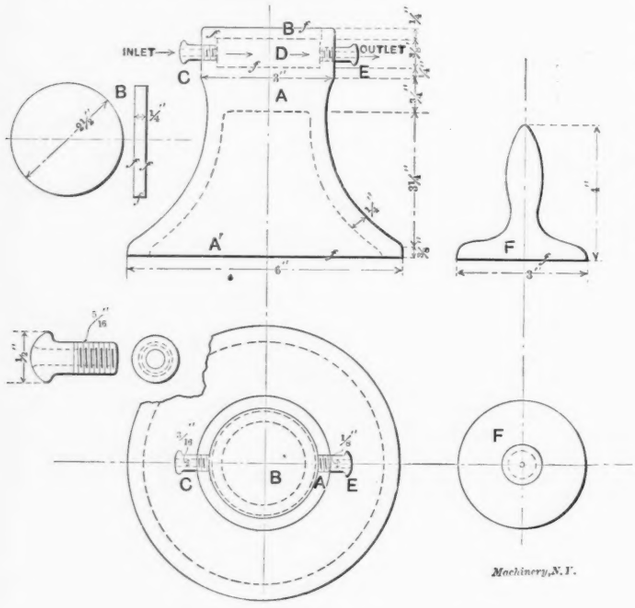
The latest design of this quick change gear makes it possible to cut both English and metric threads on the same lathe, including the English 19-pipe thread; and at the same time it greatly increases the range of special threads. But as this mechanism is not yet patented, it is not here made public.

The Burbank speed mechanism is not only suitable for thread cutting, but it is particularly well adapted for geared lathe heads, and perhaps this is its best field, because of its rigidity and flexibility of speeds, especially as these speeds can be arranged in geometrical progression. It is also adapted, however, for speed boxes for radial drills, etc. The number of gears in this mechanism is comparatively small. For instance, the number of gears on the cone for the geared head of a 16-inch lathe is only 3 for 14 speeds. This may seem incredible, but it is easily seen from the equation, $S = n\ (n - 1) + 1$, where S is the total number of speeds, and n the number of gears on the cone. In this case, S equals three times two plus one, or 7, and the back gear, or what is its equivalent in this mechanism, multiplies this 7 by 2, making the 14 speeds, above mentioned. The above figure shows a curve plotted from the design of a geared head for a 16-inch lathe, having only three gears on the cone. It will be noticed that no speeds are lost when the back gear is thrown in. In fact, it cannot be detected in the curve where this change is made. If such a curve were plotted from an old style belt-cone lathe, even of modern design, it would appear very erratic by the side of this almost perfect curve. For instance, as when throwing in the back gear, it is common to find the speed to be actually higher instead of lower than the slowest speed on the open belt, even with modern lathes of the best type.

LETTERS UPON PRACTICAL SUBJECTS.

TO HARDEN AND TEMPER THIN CIRCULAR SAWS WITHOUT WARPING.

After hardening the very thinnest saws possible to make, it is not the easiest thing to straighten them, but by employing the following method I have no trouble. I use no oil or other preparation in hardening the saws, but simply a cast iron pedestal, Fig. 1, through which flows a stream of water to keep it cold, and the hand block, Fig. 2.



Figs. 1 and 2. Hardening Pedestal and Hand Block.

A is the cast iron pedestal, having its base *A'* reduced by coring. The top of the pedestal is bored for chamber *D* and to receive the cast iron disk *B*, which is faced parallel and pressed tightly into place. Before *B* is pressed into place, however, holes for *C* and *E* are drilled and tapped into the casting *A*, these holes being made to receive brass nipples to which are attached rubber hose. Rubber hose is used inasmuch as it saves time in making the connection at the faucet and is most convenient to take down. *C*, being the inlet, is made larger than the outlet *E*, thus causing the chamber *D* to be constantly filled with water. The flow of water can be regulated at the faucet, and where there is no water faucet at the forge, a tank may be improvised by placing a pail of water above the pedestal, having a nipple connection on the side of the pail one inch above the bottom. A pail below the pedestal can serve as a drip tank. In this way a circulation of water through chamber *D* is assured and *B* is kept cold.

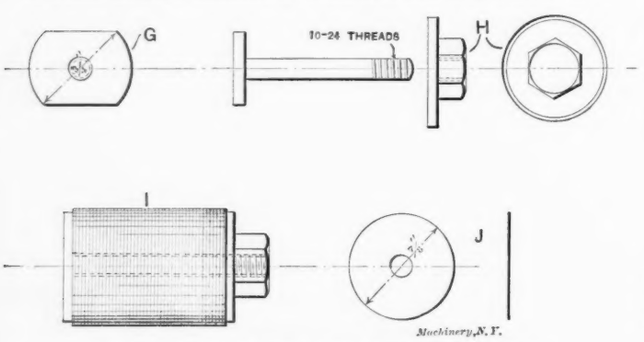


Fig. 3. Arbor for Stringing Saws when Temper is Drawn.

When sufficiently heated the saw is laid on *B* and the hand block *F* is instantly placed on top, thus cooling and pressing it flat. The hand block should not remain on the saw more than five seconds. While another saw is being heated the operator removes the hardened saw and any scale which may have accumulated. After all the saws are hardened, the hose and fittings are "shelved" until another lot is ready.

The next operation is the tempering of the saws. In drawing the temper I use a gang arbor 1¼ inch long which fits the hole in the saws closely. To prevent warping, they are strung on the arbor *G*, Fig. 3, as many being put on as possible, making allowance for a polished washer and nut, *H*. The saws are then clamped together by screwing up the nut as tight as possible.

The saws should be drawn slowly, and should be kept revolving, now and then being dipped in water. This process is continued until the desired temper is shown by the polished washer, which should be repolished after each operation.

The thinnest saws are 0.0035 inch thick, ⅞ inch diameter, and have 125 teeth. The saws give perfect satisfaction on automatic machines doing the finest class of work in the world. To harden saws 1/64 inch thick, or thicker, I would suggest using oil, putting on just enough to keep the top of the pedestal well oiled. The manner of ganging the saws is shown at *I* in Fig. 3.

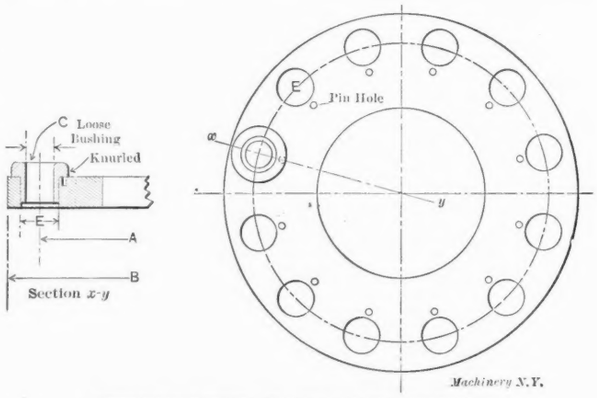
S. C. SMITH.

TEMPLATE FOR DRILLING FLANGES AND FLANGED FITTINGS.

Calvin B. Ross.

The template shown in the cut is a very useful article for the purpose for which it is intended, namely, that of drilling flanges and flanged fittings. In cases where parts are to be interchangeable or to be duplicated at different times, the only accurate method of drilling such fitting is, of course, by means of a jig or template which prevents any error arising when such parts are duplicated.

The cut below illustrates a template which combines simplicity, cheapness and beauty (as it were). The ring proper may be made from a companion flange, the size for which the template is to be used, by cutting off the head and finishing all over, thickness being approximately 1 inch. *B* is made equal to the outside diameter of the flange and *A* is the diameter of the bolt circle. A removable bushing, such as shown in section *x y*, is used and moved from hole to hole



Template for Drilling Flanges and Flanged Fittings.

as required. The advantage of this loose bushing over a stationary one in each hole is obvious, lessening the cost of the template more than one-half. The bushing is made from machinery steel, knurled where indicated, and hardened. The small pin prevents the bushing revolving, due to motion of the drill.

CALVIN B. ROSS was born in Urbana, O., 1882. After completing a high-school course he studied at the Urbana University and later at the Ohio State University, from which he graduated, receiving the degrees of M.E. and E.E. He now holds the position of engineer and draftsman with the Hoppes Manufacturing Co., Springfield, O.

I have in mind a case where a standard pressure and low-pressure drilling job calls for the same number of bolts in the same bolt circle, but different sizes of bolts. In this instance all that is necessary is to have two bushings, with the same diameter, *E*, while *C* is made to correspond with the diameter of holes required.

This is surely a neat design of a well-known scheme, and is one which will be appreciated by men having such work in charge.

CALVIN B. ROSS.

Springfield, Ohio.

A SHOP FREAK.

A somewhat interesting incident occurred, which from the standpoint of the curious, might be worth noting.

An operator was drilling a hole in a cast-iron upright. A chaplet had been cast in, near where the hole was to be drilled. The workman had a freakish notion that he could not drill any but the smallest size holes without first drilling with a smaller size drill. In this case he drilled a ¼-inch hole first. This hole barely cleared the chaplet and when the larger sized drill was used, it, of course, came in contact with the chaplet. The workman had thrown in the feed and was running at a high speed. As the drill came in contact with the chaplet its cutting was effectually stopped. The

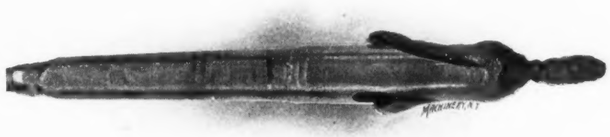


Fig. 1. Twist Drill that Encountered a Chilled Chaplet.

metal of the drill was obliged to find an opening somewhere as it was being fed in steadily at the top of the hole, so a portion continued downward into the ¼-inch hole; the remainder, by this time red hot and semi-plastic, was forced back up the flutes of the drill itself, notifying the workman upon its arrival at the top of the hole that something had gone amiss at the other end. Before the operator discovered it fully ¾ inch of the end of the drill had been forced through this process. A vise, a drift and hammer and considerable expenditure of elbow lubricant were necessary to release the drill from its socket, after removing it from the hole.

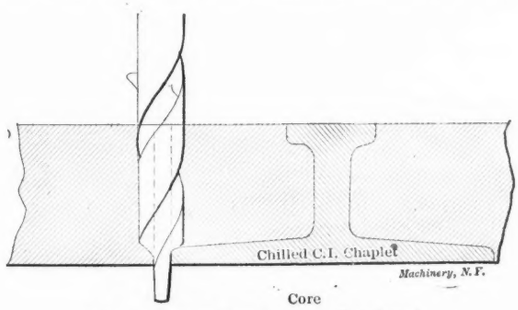


Fig. 2. Showing how the Freak Developed.

The sketch Fig. 2 will serve to illustrate what took place when the drill came into contact with the chaplet. This drill, while not of the high-speed quality of steel, had been used in all sorts of work previously and had never shown distress before. The ¼-inch drill, which, through the workman's notion, was first used, had just escaped the edge of the chaplet, which was made of hard chilled iron, and was used originally in holding the core in place when the piece was cast.

J. H. V.

TO LEVEL UP A LATHE.

When a new lathe comes in the shop the first thing to do is level it up and get it ready for business. The usual way to level up a lathe bed, or any machine of similar construction, is to true it up by the ways with a spirit level. In many cases, this might prove to be near enough; providing, however, the level being used was correct. There may be other and better ways, but the writer knows of none more simple or satisfactory than the following:

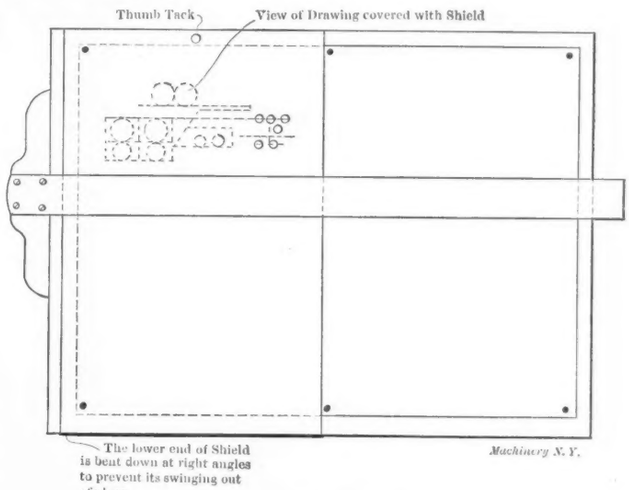
Procure a stick or narrow piece of board about six feet long, two or three inches wide, and an inch thick, and fasten it securely to the side of the carriage with a bolt or clamp and perpendicular to it. At the top, drive in a pin or nail, whichever is the nearest at hand, and from this pin suspend a common plumb-bob, letting it fall to some given point on the carriage, the point being as near the given point on the carriage as possible without touching it. A sheet of paper with a pencil-mark is all right as long as it is kept stationary. Move the carriage as close to the headstock as possible when setting the point. Now run the carriage down toward the footstock to the extreme end of the bed, and if it is not exactly level the plumb-bob will be seen to move away from the dot on the paper in the direction which the bed is out. By carefully shimming up the legs it can be made level at any point, thus eliminating the "wind" so commonly found in such machines when proper care has not been taken in setting them up. This may be an old idea to some of your readers, but it has been found to be a good one.

H. H. G.

A CELLULOID PROTECTOR FOR DRAWINGS.

Robert A. Lachmann.

It is a well-known fact that in laying out and designing any mechanism of a complex nature several erasures occur which roughen the surface of the paper and make the dirt-catching "stunt" a very easy one. Assuming that the upper right or left corner of a sheet has a side view which has been worked on for several days and is in pretty bad shape (which is generally the case, especially where the drafting room has any connection with the machine shop proper) and it is now required to draw a front view of the same object, it is, of course, necessary to transfer the center lines, make comparisons, take off measurements, etc., from the side view, and for this reason it is certainly proper to have the side view constantly in sight.


Thumb Tack
View of Drawing covered with Shield
The lower end of Shield is bent down at right angles to prevent its swinging out of place
Machinery N.Y.

Celluloid Protector for Drawings.

To cover the part already finished with a piece of paper is all right in its way and is better than nothing, but imagine the annoyance of always having to lift the paper covering in order to see the sketch. I overcome this trouble in a very simple manner; the covering consists of a sheet of celluloid (the

ROBERT A. LACHMANN, was born in 1875, at La Salle, Ill. He served an apprenticeship with the Challenge Machine Co. (formerly Schniedewend & Lee), Chicago, and has worked as a journeyman for the Sprague Electric Elevator Co., the Singer Sewing Machine Co., Rudolphi & Krummel (now the American Can Co.), and others. He was at one time superintendent of the Morgan Machine Co., and was in charge of the tool-making department of the Chicago Street Railway Co. His specialty is tool and die making.

thinnest transparent, about 0.010 inch thick) which will cover one-half of the drawing. The price of such a sheet, in this case about 12 x 18 inches, is only 50 cents, and it will save its cost over and over again. It is self-evident that by using this sort of shield the T-square in sliding across the sketch covered cannot injure it and furthermore, if the celluloid is bent at its lower edge as indicated in sketch and a single thumb tack used at the upper end it is an easy matter to shift the shield from left to right or *vice versa*. If it should be necessary to get at both views occasionally it is not even necessary to remove the tack; simply lift the T-square and swing the celluloid shield so it hangs down from the back of the drawing board.

It is a pleasure to work on a drawing with a shield of this description as the lines can be seen practically as well through the shield as if it were not there; likewise measurements can be very readily taken off.

ROBERT A. LACHMANN.

Chicago, Ill.

FINDING THE COST OF LATHE WORK.

The concern of which I write probably has one of the best equipped plants in the country, and this letter is on the turning out of a few pieces, which they make day after day at a

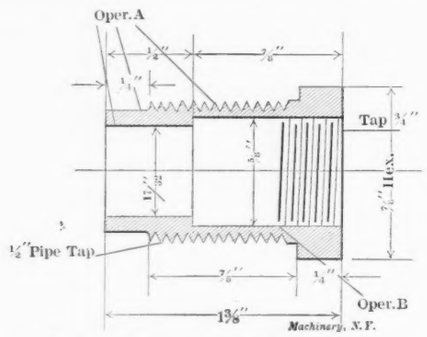


Fig. 1. Nipple made from Hexagon Stock.

record-breaking speed, and their method for ascertaining the cost of the articles manufactured is as follows:

We will take for instance the small piece shown in the sketch, Fig. 1; this is made from the hexagon bar in two operations, *A* and *B*. Operation *A* is turned out at the rate of 475 per day of 10 hours or 47½ per hour; and *B* at the rate of 200 per day or 20 per hour. We take neither the minimum nor maximum turned out, but the average and in this way the time in setting up and turning of the turret is considered in with amount turned out. Neither do we make any allowance for grinding of the tools for there are duplicate sets which the toolroom keeps in working order.

Now operation *A* is done on an Acme automatic by a 20-cent man who runs three other machines, and if he gets 20 cents per hour it makes the running cost of this particular machine 20 ÷ 4 = 5 cents per hour; if we turn out 47½ per hour, one will cost 5 ÷ 47½ = 0.1 cent. Operation *B* is done on a hand screw machine run by a 20-cent man, and he turns out 20 per hour. So 20 ÷ 20 = 1 cent for *B*; 1 + 0.1 = 1.1 cent. total cost of the operations on Fig. 1, which plus the cost of raw material equals the nominal manufacturing cost.

Fig. 2 shows a piston, which is done on five different machines in seven operations. When the operations require more than one minute they can be figured as follows:

Operations *A* and *B* are both done on the same machine, a Potter & Johnson automatic run by a 20-cent man who runs three machines. Operation *A* takes 9 minutes and *B* takes 24 minutes. 9 + 24 = 33 minutes, which divided by 3, the number of machines run by one man, equals 11 minutes for operations *A* and *B*.

The rate of the man's pay (20 cents) divided by 60 equals the rate per minute, or .33 cent. If the rate is .33 cent per minute, and it take 11 minutes, .33 × 11 = 3.63 cents, cost of two operations. Other operations are worked out the same way. Below is a form giving in detail the information needed on this piston:

Operation.	Machine.	Rate. per hour. cents.	Rate. per min. cents.	Time, min.	Cost, cents.
A and *B*	Potter & Johnson Automatic	20	.33	11	3.63
C and *D*	Radial Drill	20	.33	5½	1.81
E	Small Drill	15	.25	4	1.00
F	Grinding Mach.	18	.30	11¼	3.37
G	Lathe	25	.41	13½	5.53
				Total,	15.34

15.34 cents, cost of piston operations plus the cost of casting, equals the nominal manufacturing cost of piston, that is, without the cost for supervision or shop burden.

Cleveland, Ohio. CARL D. SALISBURY.

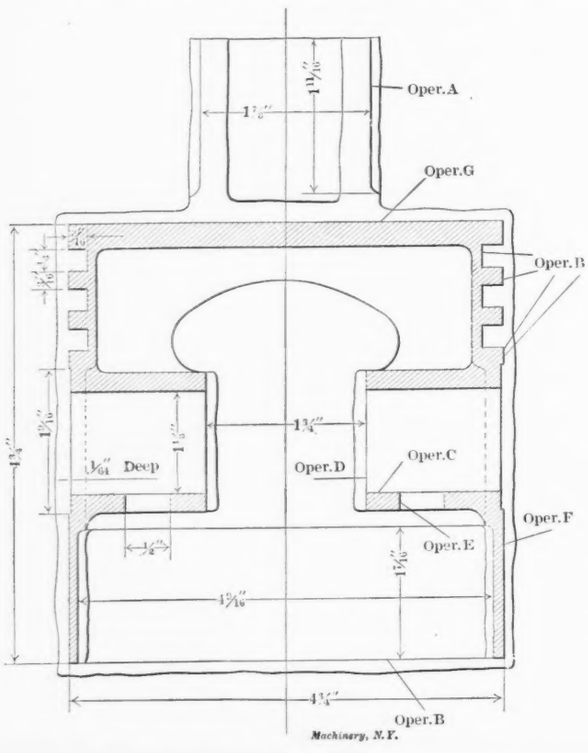
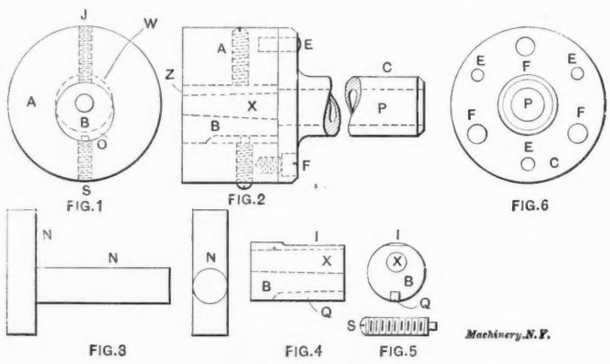


Fig. 2. Gas Engine Piston selected to Illustrate the Finding of the Cost of Lathe Work.

NOVEL HOLLOW MILL.

The accompanying sketches show a hollow mill designed to be used in a hand screw machine for machining the forgings, Fig. 3, on the surfaces *N N*. Two of these mills were made, one rougher and one finisher. They were constructed with the view of saving labor in replacing wornout tools. The con-



Novel Hollow Mill.

struction consisted of an outside mill *A*, bored eccentric to receive the inside mill *B*. *B* is held in position with set-screw *J* and screw *S*, which latter has its inner end turned to fit the spline *O*. These mills *A* and *B* are fastened to the shank *C* (which fits the turret head) by screws *F* and the dowel pins *E*. Figs. 4 and 5 show the inside mill *B*. Flats are milled on top of *B* at *I* for the screw *J* to seat against, and the spline is milled on bottom as above stated. The hole *X* is slightly tapered back from the cutting edge *Z* for clearance, and hole *P* in shank *C* is drilled for chip room.

It is obvious that if this mill were made solid, its life would be short, as the teeth get severe usage at the center, especially in the roughing tool, which has to cut against the rough scale of the forging. We found on trial that the outside cutter *A* would outwear seven inside cutters *B*. Outside dotted lines *W* represent the true sweep of the work against the mill; *A* and *B* being eccentric prevent any fin forming on the work where the mills match, otherwise if the mills were made concentric this trouble would result. E. W. NORTON.

COMMENT ON "MILLING CUTTERS."

I wish to call attention to a mistake in Fig. 7, in the article "Milling Cutters," appearing in the April issue of MACHINERY. This drawing shows the cutter being cut with negative rake, which, I presume, was not the intention of the author. I would let this pass as a slip of the pen, were it not that I have seen this same mistake in practice a number of times. The cutting line should have been behind the center line instead of ahead of it.

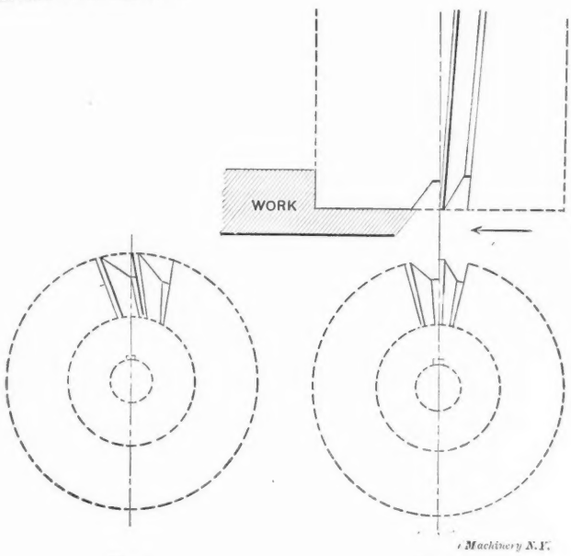


Fig. 1. Fig. 2.

In this connection, I wish to remark here that the use of rake in milling cutters is not nearly so common as it should be. It is true that not every cutter can be used with rake, but it is equally true that only a small portion of the cutters which might have rake are ground that way. There are two main reasons why the rake for a milling cutter may not be advisable: one is, that a cutter ground with rake is liable to produce a rather poor surface; the other is, that the spaces between the teeth are liable to be filled up with chips. It is generally easy to avoid trouble on the latter score by providing means for washing the chips away or blowing them out. As far as the first reason is concerned, this is not quite so bad as it looks. In the first place, where one operation is done, on a great number of parts, it would be easy to have two cutters, one for roughing and one for finishing. This is something which, for some reason, is too much neglected in milling practice. I presume there is a bit of ancient history behind this practice. It is not so long ago that most shops had only one or two milling machines, which were mainly used for tool work, or such operations as could not possibly be done on any other machine. As a consequence, there was a very great number of costly milling cutters for only one or two machines. It was quite natural then, that this large number of cutters was not doubled again so as to get one cutter for roughing and one for finishing. As a rough surface was positively inadmissible, it followed that the cutter had to be made in such a way that a good surface was produced. That the cutter was not a decided success as a roughing cutter was regretted (if it was noticed at all), but this defect was considered as hot weather in summer—not nice, but what are you going to do about it? Now that the milling machine is beginning to be recognized as a factor in the rapid production of work in manufacturing shops, it seems that the time is past when people could be satisfied with a slow cut, because the same cutter which takes a fast cut will not make a good surface.

It is further remarkable that in almost all cases that have come to my notice the rake of the teeth of face or end cutters is given in the wrong plane; that is, the teeth are ground with an angle in a plane where this angle does no good at all. The impression seems to prevail, that the radial teeth of the end cutter do the cutting, whereas, as a matter of fact, this is done by the cylindrical part of the cutter.

Fig. 2 shows a cutter at work as an end cutter. If this cutter were feeding in the direction of its axis, then it would be proper to give it rake, as shown in Fig. 2. However, as it feeds in the direction of the arrow, at right angles to its axis, the rake should be given as shown in Fig. 1. It is very seldom, though, that I have seen this done. This matter of giving rake the wrong way becomes a very serious matter

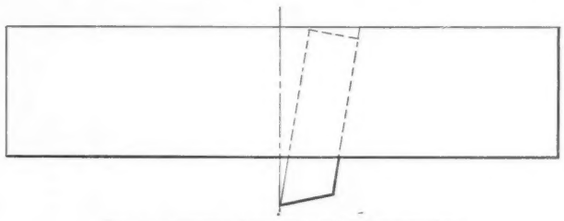


Fig. 3. Common Inserted Cutter Construction.

with milling cutters of large size with inserted teeth, such as are used for rotary planers. It may seem almost incredible that such serious mistakes are made with a tool so well known, but I have seen it time and again.

Fig 3 shows a cutter with inserted teeth of common construction. The slots for the cutters are milled at an angle, so as to produce the necessary rake without grinding. This is quite common practice. As a matter of fact, however, this

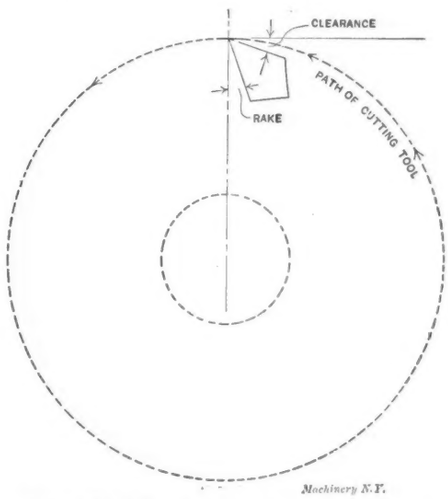


Fig. 4. Showing how the Angles should be Ground.

angle of the slots does not produce any rake whatever. Fig. 4 shows one of the cutting tools of the milling cutter and its path. It is easy to see from this figure how the angles should be ground.

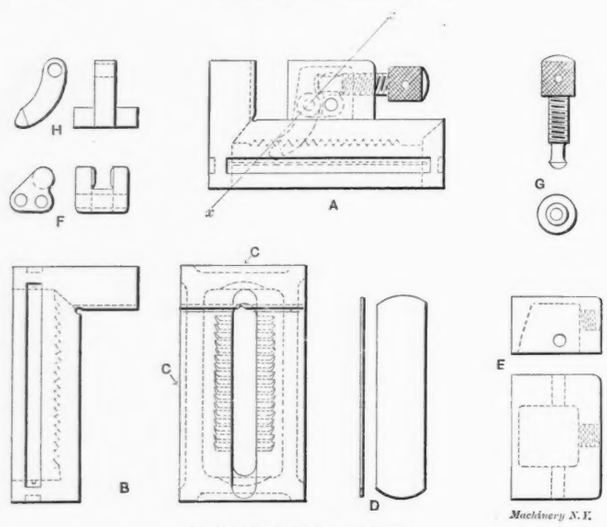
Much more could be said on this subject, but this will do for the present. A. L. DELEEUW.

Hamilton, Ohio.

TOOLMAKER'S VISE.

In the shop where I was employed some months ago there were about 75 toolmakers and every one seemed to have better ideas than the other, paradoxical as it may seem. This simply means that they had different views. One day one of them showed the other a design of toolmaker's vise. It was well demonstrated and every one seemed to like it very much, but when he made it they one and all had something to say against it. The principal objection seemed to be that the hook screw extended above the top of the rear jaw so that when using it for grinding or planing lengthwise the nut was in the way. Another vise was immediately made by another toolmaker, us-

ing the same design but with the hook screw shortened and the nut countersunk into the rear jaw at an angle of about 45 degrees. With this a cup-wrench was required to tighten the nut. At the same time still another vise was made of an entirely different design of tightener in the rear jaw which when compared with the other proved to hold the work much more tightly when screwed up with about the same power. It is a common saying that it takes a good man to design a creditable job, but any fool can criticise, and I must confess that I am one who is guilty in that respect.



Toolmaker's Vise, and Parts.

But having found this tool very simple and convenient in its construction, I thought it worth while to illustrate it in MACHINERY, for we all know how difficult it is at times to handle small pieces of work; it is often necessary to solder them onto a plate in order to do accurate work. The vise is made square and parallel on all sides and is 2 13-16 inches long, 1½ inch wide and 1½ inch high. The sketch at *A* shows the vise assembled, and surrounding it are the parts. *B* is the body made of tool steel and pack-hardened, ground and lapped square all over; it is milled out inside and 19 ratchet teeth are cut with an end mill at an angle of 30 degrees. In the center is a slot with round ends in which the hook *H* can move freely. A V-groove of 45 degrees angle is cut in the face of the stationary jaw square with the base so as to hold small round pieces vertical. On each end inside is cut a narrow slot 1-16 inch deep to fit the thin spring plate *D*, which is inserted to prevent the hook dropping down. The movable jaw *E* is also made of tool steel and pack-hardened, ground and lapped all over. A recess is cut in the under side of the sliding jaw with a round cornered end-mill, and a pin-hole is drilled transversely through the jaw for the pin to hold lever *F*; at the back a 5-16 inch hole is drilled and tapped for screw *G*. The hook *H* is made of tool steel hardened in oil and drawn to a straw color. It is made T-shaped, the body being slightly less than ¼ inch thick so as to work freely in the slot in the base, and a pin-hole is drilled at the upper end through which a pin is fitted to join it to the lever *F*. Lever *F* is made of tool steel pack-hardened while screw *G* is spring tempered; the screw is made 20 pitch left-hand so that when turned to the right it will tighten the jaw. The line *x*—*x* through the point of the hook and the centers of the lever *F* when in line should make an angle of about 45 degrees so that when the screw is tightened the jaw will be drawn down against the base with about the same resultant pressure as is applied against the stationary jaw.

O. WESTBERG.

MOUNTING BLUEPRINTS.

We have heard it said: "Of making many books there is no end," and it is equally true that of making many blueprints there is no end. It is, of course, very evident that the life of a blueprint is limited, but a blueprint which is properly mounted will outlast several that are unmounted. Many think it is a serious matter to mount prints satisfactorily, and so they don't try. It is really a very simple matter, however, and the results will amply justify the effort. Sheet iron, about 18 or 20 gage, either black or galvanized, makes a very satisfactory mount, but must be coated with shellac before using to prevent chemical action destroying the print. Mill board about ⅛ inch thick makes a lighter mount, but not so durable. When using the mill board, a piece of paper the same size of the print must be pasted on the back to prevent curling, and the face of the mount should be brushed over with paste. To do the mounting you will require a brush and a small rubber roller, which can be purchased for fifteen cents from a dealer in photographic supplies. To make the paste, dissolve a heaping tablespoonful of corn starch in a pint of cold water. Heat while stirring until it just begins to boil. Lay a print face down on a table or bench, brush the back evenly with paste, pick the print up by two adjacent corners, holding with pasted side away from you. Standing in front of the mount which is lying on the table, a quick forward motion of the hands will cause the blueprint to assume a nearly horizontal position, owing to the resistance of the air, and it can be quickly lowered into place on the mount. Now, with the roller, beginning at the center and working toward the outside, the print can be pressed into contact at all points. If the paper wrinkles, lift the corner nearest and get busy with the roller, working from the center always. You will be surprised to find how easily you can handle a 24 x 36 print by two corners after the first few trials. After mounting, the prints may be varnished or given a coat of shellac if desired. A hole should be provided at the top and a place provided for each workman to hang prints when practicable.

W. W. W.

WEAK STEAM FITTING.

The accompanying photographs illustrate very clearly what it is well to avoid in the way of steam fittings.

I had occasion a short time ago, to use a half-inch plug cock for a day, and so went to a hardware store and took one out

Fig. 1. Showing Collapse of Plug Cut.

of stock, on the assumption that anything would probably last for that length of time. It was put in a steam pipe subjected to 165 pounds pressure, and leaked the first time it was

Fig. 2. Showing Softness of the Metal.

shut off. This leak grew worse and in a half-day the plug was removed in the condition shown in the illustrations. It worked all right so long as it was open, but when it was closed the steam pressure caused one side of the slot to col-

lapse and forced the other against it and into the passage in the case, to such an extent that the outline of the latter appears clearly cut in the body of the plug.

The cock was simply too light, and the excuse would probably be made by the maker that it was not designed for such a high pressure. To which the reply courteous would be: "If it collapses so completely under a pressure of 165 pounds, what is the real factor of safety at its proper working pressure of certainly not less than 100 pounds?"

The fact is, the maker is looking for trade, and the buyer is looking for a bargain, so the former cut down his weights until he produced an article that could undersell others and which was as worthless as it was attractive in price. It is merely another case of the bargain counter spirit run riot, an instance of the expensiveness of low-priced goods, and a good warning that the solid and substantial are the cheapest goods in the end, especially in the matter of steam and water fittings, where the cost of labor for replacement is usually much more than that of the goods. GULF.

THE KNIFE-EDGE STRAIGHTEDGE.

Mr. F. N. Gardner, in the November, 1905, issue of MACHINERY, has made some statements on lapping straightedges that are so contrary to my practice that I am tempted to take up the subject with him.

His style of convex lap (Fig. 4) I know would require "an amount of patience and perseverance that would make a Jap turn green with envy." It is bad enough to make a straightedge, but when you come to make a square edge at the same time I don't see how he could do it on that lap. And that test bar of "chilled white iron" might have been slightly concave or convex instead of straight; it would have stood the test of cotton fiber that he tells about just as well.

A lap that won't make a six- or seven-inch proved steel straightedge ought to be planed off, then scraped to a surface plate as flat as you can get it. If it is slightly convex it will help you in lapping *flat work*, which is inclined to curl away from the lap when being lapped, causing the ends to become thin when the work is lapped on both sides. But in making a proved straightedge the lap must be as flat as possible.

It is a known fact that if three surfaces fit each other, as proved by placing any two of them together, the surfaces must be straight.

Take a piece of ¼ by 1½ by 7-inch tool steel, bevel one edge down to about 1/16 inch thick, then harden it back about a quarter of an inch on the narrow edge, then draw it to a straw and grind all over. This wide edge, a knife-edge and the lap make three surfaces that have to fit each other or I don't want the lap for fine straight lapping.

To prove the lap flat take the wide straightedge, place it against a parallel to hold it from rocking and go all over the lap (after charging with abrasive); then take the knife-edge (without the parallel) and do likewise. Now you have two opposites of the lap and if they fit one another every time you lap them on the same lap they must be straight and the lap flat, and if there is an error it will show double the error of the lap.

I have lapped a good many straightedges and knife-edge squares on laps that would stand this test and have never been bothered with heat expanding or distorting the straightedge.

Lapping is nothing more than refined peening. Take a piece of cast iron 1½ by 1½ by 7 inches, scrape it to a surface plate on two sides and give a few rubs on a charged lap, on one side. The cast iron piece will curl and about as quick as though it were hit with a hammer on the same side that you have just lapped—and they say: "Don't hammer stock." A lap will also curl hardened steel, although I have worked steel that the emery wheel or lap did not seem to affect.

Carborundum makes a good abrasive. Keep your grades that will not sift through cheese cloth, in tin pepper boxes, also your cheese cloth bags in marked tin boxes. I can't see how Mr. Gardner charged his lap on the same charging plate for the finer grades after using coarse grade.

Mr. Gardner speaks about the wear upon the charging block and lap that I agree with. It is caused by the abrasive rolling between the two plates and has the same effect as a knurling tool (but of course not so pronounced).

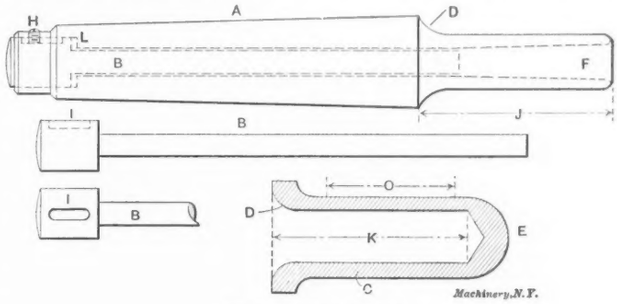
To overcome it I use a hardened piece of steel to charge the lap with. I find there is too much rubbing done in recharging a lap. You can charge a grey iron lap the best by using a few drops of kerosene, then sift the abrasive onto the lap through the cheesecloth bag; use enough benzine to spread the charge. Use another piece of cheesecloth for the rubber. This leaves a thin film of kerosene oil and abrasive that seems to make steel melt away, it cuts so fast.

You can lap an oil stone on a lead lap flat enough to do a surprisingly good job for roughing the straightedges. When lapping a glass test bar remember that high finish and accuracy do not travel together. The seemingly rough surface will be more accurate than a scratchless, high-finished one to work with.

Laps thinner than two inches thick are liable to distort when used much. You will be deceived and lay the trouble to the lap wearing through use, but if charged right it will stand a good test after a year's constant use. SCOTTY.

MILLING MACHINE COLLET.

The cut shows a handy collet to be used in a universal or hand milling machine. The taper hole *F* in the collet is made to fit standard tapers; a straight hole is drilled and counterbored in the rear end to receive the knockout plug *B*. *B* is an easy fit in *A* and is held from working out by the screw *H* and the elongated slot *I*. The thimble *C* is made a loose fit over the neck of collet *A* and is used to drive the collet into the spindle. Distance *K* is a little longer than distance *J*, so the force of the blow will strike on *D* and *D*. For this purpose the radii of *D* and *D* are made the same. The end of *C* at *E* is rounded to centralize the blow when collet *A* is driven into the spindle. *C* is knurled for the distance indicated at *O* and it is spring tempered. By this construction as many cutters can be used as needed without removing collet *A* from the spindle. Jammed and sprung collets that always run out of true are also done away with. Of course the collet can be removed by driving the knockout plug further in until it shoulders against *L*. E. W. NORTON.



Milling Machine Collet.

* * *

DANGER OF RELYING ON SECRECY TO PROTECT A PROCESS.

Some years ago the Goldschmidt Co. of Essen, Germany, perfected a process of detinning tin scrap but instead of patenting the process they depended on secrecy to make the discovery profitable. The usual result of such practice followed. Two of the employees knowing the secret, proved unfaithful and sold their knowledge to a concern which commenced the work in Holland and from there it was brought to America. The American concern in turn were served in the same manner. The result was that undesirable competition was established by two plants, one at Paulsboro, N. J., and the other at Joliet, Ill. The company first on the ground in this country commenced suit against the competitor seeking to enjoin them from using the knowledge obtained through the defection of one of their employees. The case was thrown out of court as the court would not stain its hands with such disreputable proceedings, none of the parties having good standing. The operation of a plant on the principle of secrecy puts a premium on dishonesty. The patent laws of most countries offer adequate protection for most inventions and discoveries; if that protection is not sought, but rather that of secrecy, the possibility of recovery of damages in case the secret is stolen by competitors is very slight indeed.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TO TRUE UP OILSTONES.

Sprinkle coarse grain emery or corundum, over a planed cast-iron surface, then rub the stone over this by hand. This will true up the face of any kind of an oilstone sooner than any other method I have ever tried. L. E. MUNCY.

Syracuse, N. Y.

TO DRILL HARDENED STEEL.

Thin steel, such as saw blades that are very hard, can be drilled with comparative ease by keeping the center punched down with a center-punch and grinding the drill nearly flat on the end. Run at slow speed with considerable pressure, and dry. MILTON BURGESS.

Cleveland, O.

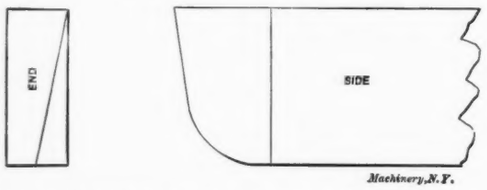
TO MAKE A SIMPLE CASTING FROM A BROKEN ONE.

To make a simple casting of precisely the same size as a broken one without the original patterns, put the pieces of broken castings together and mold them and cast from this mold. Then anneal the new casting by heating it in a slow charcoal fire to a dull red heat, and then covering it over about two inches with fine charcoal with plenty of dry ashes on top. Let it lie until cold. The annealing treatment will permanently expand it to the original size; it also makes a casting that is less liable to break. J. W. WILFORD.

St. Joseph, Mich.

TO TURN RUBBER.

To turn soft rubber such as typewriter rollers I use a very sharp tool as shown in the cut, and run at a rather fast speed



with feed about 1/16 inch per turn and finish with sand-paper. It makes a very much better job than one would think.

Cleveland, O. MILTON BURGESS.

TO DETECT A SOUND IN A NOISY SHOP.

It is very important, when a machine in motion produces the peculiar noise, indicating that some parts are cutting, to locate the trouble immediately. Sound is produced first, and then heat. Sometimes when the parts get hot, it is too late to remedy the trouble, as they may be so badly cut that they are ruined. To detect the sound quickly, before much heat is produced, apply to the ear one end of a rubber tube, and move the other end about to find the precise point the noise comes from. Stopping the other ear helps. I employed this way of detecting a sound in a very noisy shop, with success, several times. Try it and you will be surprised at the result.

Los Angeles, Cal. J. M. MENEGUS.

TO REDUCE THE SIZE OF A HOLE IN WROUGHT IRON, STEEL OR CAST STEEL PIECES.

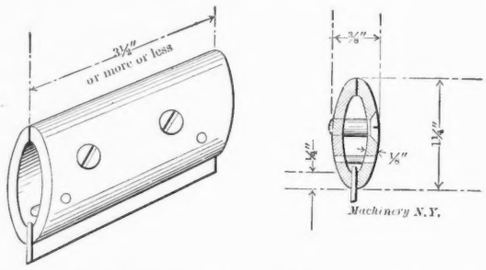
When a hole has been bored out too large by mistake, if the shape of the piece will allow, the following method may be used to reduce the size of the hole:

Heat the piece redhot, and plunge it half way in cold water, taking care to keep the axis of the hole perpendicular to the surface of the water. Half of the piece will become cold and shrink. The other half that is still red will shrink while hot, being pulled together by the cooled part, and when it gets cold will shrink still more, becoming smaller than the original size. Heat the piece again and plunge it in water as before, taking care to plunge the end opposite to the one that was plunged before. Repeat this operation, dipping the two ends of the piece in water, alternately until the size of the hole has been reduced enough to allow a nice cut to be taken to bore it to the right dimension. J. M. MENEGUS.

Los Angeles, Cal.

A USE FOR BROKEN AND WORN-OUT HACK SAW BLADES.

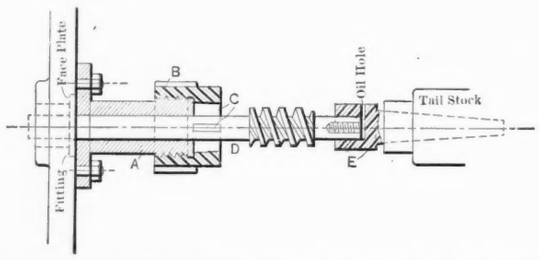
A useful scraper for wood is made as shown in sketch. The handle is shaped as shown from steel or brass. The dowels hold the parts of the handle in line, and prevent the blades from slipping; they also locate the blades. The blade being very thin can be easily sharpened and kept sharp. It makes



a most useful patternmakers' or joiners' scraper, and the blades cost nothing to replace, broken or worn-out hacksaw blades being used for the purpose. A rough and ready handle can be made by sawing a narrow slit in the end of a piece of hard wood and driving in the blade tightly. HARRON.

THREADING COMPOSITION STEMS.

Mr. Eberhard's article, "Drill Press Centering Device," in the January issue calls to my mind another way of threading composition pieces, very similar to his. We also had several hundred stems in number, and the same troubles, one end being tapped. The accompanying sketches show how we got out the job.



A is a cast-iron piece fitted and bolted to the face-plate of a lathe, and bored the same size as the stem. The outside is threaded and turned taper for the steel nut *B*. The end of the piece *A* is split as shown at *C*, the length of the taper. As is readily seen, the nut, being screwed with a spanner, causes the split taper end of the piece *A* to close and firmly hold the stem *D*. *E* is a special steel center bored the same size as the stem. Using this device the composition pieces were threaded in a very satisfactory manner. J. M. MENEGUS.

Los Angeles, Cal.

TOOLS FOR SETTING MILLING MACHINE VISE SQUARE, AND PARALLEL WITH THE SPINDLE.

The device shown in Fig. 1 has been nicknamed the "wing-wang" in our shop, and is used for setting a milling machine vise square with the spindle. It is made of machine steel

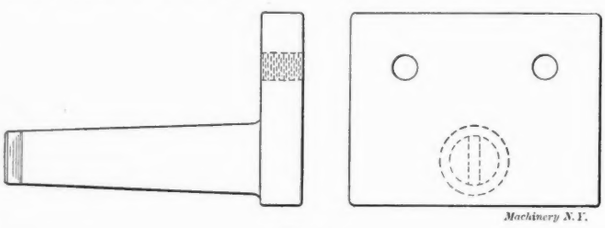


Fig. 1.

turned with the face square with the shank and is fitted to the taper hole of the spindle of the milling machine. The one we have is 4⅜ inches long, ¾ inch thick and 3¼ inches wide.

It does away with the cut-and-try method of setting a vise with the indicator gage, and saves much time. The way it is used is simply to mount it in the spindle with the wing down and then the swivel clamping screws of the vise are loosened and the front jaw moved forward until it touches the wing; then the vise is screwed together and the clamps are tightened. This simple operation squares the vise with the spindle, whereupon the "wing-wang" is removed.

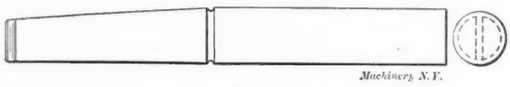
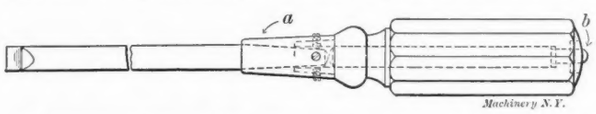


Fig. 2.

Fig. 2 shows a mandrel for setting the milling machine vise with the jaws parallel to the spindle. It is about 1¼ inch diameter with a taper shank to fit the spindle and projects about 12 inches from the spindle when in place. To use it the vise is strapped to the platen and the swiveling screws are loosened; then the vise jaws are opened and the table is raised so that the jaws may grasp the arbor, whereupon they are tightened upon the mandrel and the clamping screws are tightened; loosen the jaws and remove the mandrel and you are ready for work. O. WESTBERG.

SCREW DRIVER WITH KNOCKOUT PIN.

The cut shows a neat screw driver for all-around shop use for which a number of blades can be conveniently used with one handle; it was introduced into the shop by one of our toolmakers. To make it, procure from a hardware store a rosewood handle of the style shown in the cut and make a steel cap which is bored taper in the front end and is held in position by four screws. These screws project into the bore and fit against a square which is ground on the end of



each screw driver blade. In the handle a ¾-inch hole is bored from one end; and from the other end a ¼-inch hole, which is counterbored to ½ inch diameter and 3/16 inch depth. In this is fitted a steel bushing. The pin *b* is made a loose fit in the handle. The blades, which may be made of any size drill-rod, are turned to fit the handle. They are removed by simply knocking the end of the handle on the bench so that the pin *b* loosens the blade. O. WESTBERG.

MAINSPRING KINKS.

No spiral mainspring should have a kink in it, but there are one or two kinks in reference therewith, which are worth learning and remembering. The first is in relation to broaching the hole by which it is pinned to the barrel or other part which it rotates, or which serves as an abutment to enable it to drive another part. Usually this hole is broached at right

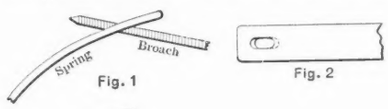


Fig. 1

Fig. 2

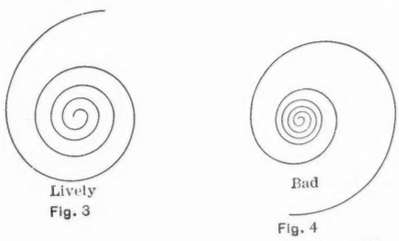


Fig. 3 Fig. 4

angles to the face of the spring. But if the hole be made obliquely through, as shown in Figs. 1 and 2, it will give a sharp edge on the holding side, which will get a much better grip on the pin, stud or hook, than where the hole is circular and all its edges at right angles instead of acute on one side and obtuse on the other. Of course the sharp edge is to come where it will bite the hook or pin.

The second kink is in choosing a mainspring which shall be "lively" and the pressure of which shall increase uniformly. Reference to Figs. 3 and 4 will show what kind to choose. Fig. 4 is the way that a slow and irregularly-acting spring will look when allowed to lie free on a table; Fig. 3 is the way that it should lie. Consequently in choosing a spring, where it is desired that the response shall be lively and the pressure diminish in a regular ratio instead of in the one that is variably decreasing, one should be picked out that lies like Fig. 3.

Hannover, Germany. ROBERT GRIMSHAW.

CAST IRON GAGES.

In making up large plug gages it is a usual custom to make them out of tool steel, hardened and ground, but I find that fine gray iron, carefully turned and ground, gives good satisfaction and lasts a long time; besides cast iron lends itself to cored construction which lightens the gage. It is also convenient to change the handle from one to the other, in case there are different sizes. Fig. 1 shows a straight plug 3 inches

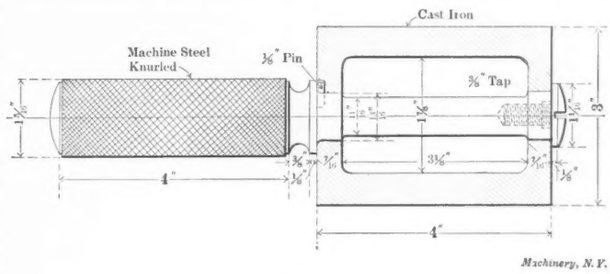


Fig. 1

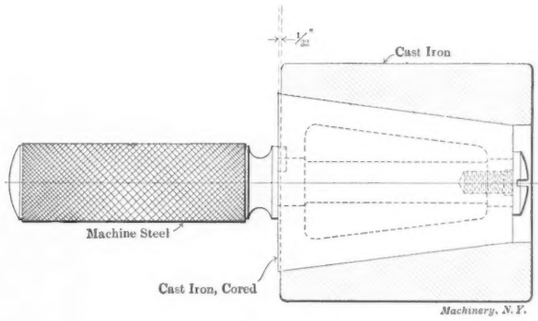


Fig. 2.

diameter, and Fig. 2 shows a taper plug and shell gage, using the same handle. In making taper rods and taper holes the gages are used as follows: The plug is allowed to extend out of the hole 1/32 inch after reaming, and if the rod is fitted to within 1/32 inch of the shell, when they are tightened together, it will be about right to give them a good seat. Usually for brass I allow a little more than 1/32 inch.

I. N. QUIRE.

TO SOLDER SMALL PIECES TOGETHER—NOTES ON SOLDERING.

To solder several small articles together that are hard to keep in place, bind them together with aluminum wire. The wire can be easily removed after soldering as the solder does not stick to aluminum. It is much easier to solder iron or steel pieces together if each surface is coated with solder beforehand.

To re-tin a badly burnt soldering copper, file or grind till flat and bright, then place some pieces of coarse emery cloth and rub briskly with the soldering copper when hot.

For soldering brass or copper the soldering pastes on the market are far more satisfactory than acid and do not corrode the work. MILTON BURGESS.

Cleveland, O.

SMOOTH SCRAPING ON STEEL.

Dip the scraper in turpentine when scraping steel and you can produce good results much more easily than when used dry. JAMES A. PRATT.

Howard, R. I.

SHOP RECEIPTS AND FORMULAS.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas, thus putting them on record for the general benefit of the craft. All published receipts are paid for.

172. PREPARING FINE OIL FOR DELICATE MACHINERY.

Put small zinc and lead shavings in equal quantities into best olive oil, and place the oil in a cool place until it becomes colorless. This oil is the best obtainable for fine mechanism.

O. G.

173. TO WRITE WITH COLOR ON A DRAWING THAT IS TO BE VARNISHED.

When it is required to color or to write with color on a drawing or blueprint which has to be varnished later, mix a little isinglass with the color; this will prevent the color running when the size is applied. H. L. MILLAR.

Manchester, England.

174. BLACK VARNISH FOR IRON.

A good black varnish for cast iron and forgings can be made of ¼ pound lamp black; ½ pound resin; 1 pound asphaltum; 1 quart turpentine spirits; and a small quantity linseed oil. The lampblack is first rubbed up with the linseed oil, no more oil being used than necessary for this purpose. The other ingredients are then mixed with it thoroughly. O. G.

175. IRON CEMENT.

The following iron cement, if properly prepared and applied, will unite broken iron parts very strongly, and may be found useful oftentimes for repairing broken machine parts of comparative unimportance. Mix equal parts of sulphur and white lead with about one-sixth part of borax and incorporate the three together thoroughly. When ready to use the mixture wet it with strong sulphuric acid and spread a thin layer of the cement on the joint to be united. Clamp together for five days when the joint should be dry and sound.

St. Joseph, Mich. J. W. WILFORD.

176. TO FINISH WOODEN HANDLES, GUN STOCKS, ETC.

The wooden parts of tools, the forearms and stocks of guns, etc., are often made to have a fine appearance by French polishing, but this finish adds little or nothing to their durability. A much better finish is to soak the wood in linseed oil for a week and then rub it with an oil-soaked cloth a few minutes every day for a week or two longer. This solidifies and preserves the work. A. L. MONRAD.

New Haven, Conn.

177. TO COAT BRASS OR COPPER WITH TIN.

To tin brass or copper melt 5 pounds of tin and pour same into a tank containing one ounce of cream of tartar in about 8 gallons of water. This must be done a drop at a time to subdivide the tin so as to give a larger surface for the cream of tartar to act upon, and have the bottom of tank covered with tin. Then put a fire under the tank and place parts to be tinned in the tank and let them boil for about one hour, or until they are coated sufficiently. H. C.

178. CHEAP CEMENT FOR GENERAL USE.

To make a cheap cement for general use, mix gum acacia (pulverized), 1 ounce; French isinglass, 2 ounces; vinegar, 4 ounces; essence of sassafras, 5 drops. After mixing allow it to stand for 12 hours, then heat until thoroughly dissolved when it is ready for use. For covering pulleys with leather, paper, etc., add ½ ounce glycerine to one quart of cement; heat and use while hot. Oily belts can be successfully spliced with this cement by rubbing the scarfed ends with powdered sal-soda and applying a coat of cement, which is allowed to dry; then apply a second coating and put together. J. H. V.

179. TO BLACKEN TIN FOR LAYING OUT.

Very often in the shop and also in the drawing room we want to lay out some piece of work for trial on something which will show fine accurate marks, but cannot obtain a piece of sheet zinc. I have used something which is just as good and more likely to be at hand, and that is a sheet of bright tin plate rubbed over with a piece of waste dipped in a sulphate of copper solution. This is made of water and blue stone with oil of vitriol added in the proportion 1 of vitriol to 50 water. Rub the tin thoroughly, keeping the waste wet with plenty of fresh solution and soon you will see spots of brass, then of copper, then a dark gray, nearly black, which wipe dry, and you will have an ideal surface to lay out on.

The above is a kink which I have found very useful.

Ilion, N. Y. F. W. BACH.

180. LUBRICANT FOR THE V'S OF LARGE PLANERS.

When very heavy work is to be done on a planer it may happen that the oil or other lubricant used on the ways of the planer does not possess sufficient "body" to resist the pressure and the wearing surface will be cut or badly "roughed up." The writer had a case wherein the planer table weighed eleven tons and the load to be put upon it thirteen tons, making twenty-four tons in all. The bearing surfaces of the V's appeared very narrow to successfully support such a weight. To avoid cutting, the surfaces were lubricated with a mixture of one gallon of "Vacuum" cylinder oil and one pound of Dixon's flake graphite. The planing job was easily and successfully done with no injury to the wearing surfaces.

Neponset, Mass. OSCAR E. PERRIGO.

181. ACIDS FOR ETCHING.

Soft Steel.—Nitric acid, 1 part; water, 4 parts.

Hard Steel.—Nitric acid, 2 parts; acetic acid, 1 part.

Deep Etching.—Hydrochloric acid, 10 parts; chlorate of potash, 2 parts; water, 88 parts.

Etching Bronze.—Nitric acid, 100 parts; muriatic acid, 5 parts.

Brass.—Nitric acid, 16 parts; water, 160 parts. Dissolve six parts potassium chlorate in 100 parts of water, then mix the two solutions and apply.

Where the name, initials, or monogram is etched on a tool, for instance a square blade, black asphaltum varnish makes the best "resist." Have a rubber stamp made with the design you wish to etch and stamp the tools with the same using the varnish as you would ink on the stamp, the stamp having a fancy border around the outside edge. This method leaves the letters or design in relief and makes an unique appearance. E. W. NORTON.

182. TO BLEACH BLUEPRINTS.

It is occasionally necessary to bleach blueprints when it is desired to make drawings for photographic reproduction. Blueprints are sometimes so faded that it is impossible to trace them, in which case I ink the lines of the blueprint and then bleach out the blue leaving the black lines on the white ground. The process of bleaching is extremely simple and is one that I developed about eight years ago. I had found it impossible to make tracings from blueprints which were very much faded, or which had been over- or under-printed. After experimenting for a month or so, trying different preparations, I finally hit on the following combination: 1 gallon lukewarm water and ½ pound bicarbonate of soda. Of course this proportion is not exact, and has to be used with caution; when in doubt prepare a little solution and make a test of a small piece beforehand as it will be found that some prints will not bleach as others do. Do not allow the inked-in prints to remain in the solution any longer than is absolutely necessary for no matter how waterproof the ink may be it is impossible to keep it from running a little. Freshly made blueprints, that is, those not more than a few months old, work best. As soon as the print is bleached take it out of the solution by the corners, being careful not to touch the ink work. Too much soda is harmful as it deposits white dust on the lines. This, however, can be removed by re-immersion in clean water. FRED DIBELIUS.

New York.

* * *

Don't be contented with being merely a lathe man, or planer man, but aim to be what is termed "an all-around man"; then you will stand a much better show of being promoted.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

ADJUSTABLE MULTI-SPINDLE DRILL.

The half-tone shown herewith illustrates an adjustable multi-spindle drill designed especially for repetition work on automobile crank cases, cylinders, pumps, etc., and electrical slate work. The machine is of the construction which employs a movable head carrying a number of drill spindles attached to adjustably slotted arms, the separate spindles being driven from the geared head through a series of universal joints. This arrangement permits the drills to be arranged to follow a circle, square or any rectangular layout within the capacity of the head. The spindles themselves are of tool steel with ball bearings for thrust running in bronze bushings, and have a vertical adjustment on the arm. The head on which they are carried may be made round or rectangular, or any

Baush Adjustable Multi-spindle Drill.

shape desired to suit the general run of work in the shop where it is to be used; the size of the head may also be varied together with the number and size of the spindles supplied with it. The cut shows a No. 10 machine fitted with the largest head which can be supplied for this size of machine, and, by using the smallest size spindles, 16 holes may be drilled at one time, varying from 3/16 to ½ inch in diameter. The least distance under these conditions from center to center of spindles would be 1⅛ inch, while the longest layout between centers of the extreme spindles would be 16 inches to 20 inches. It will drill 16 one-half inch holes in cast iron 1 inch deep in 20 seconds, either using high speed or carbon drills as may be desired, a two-speed countershaft being furnished for this purpose. The head is counterbalanced and to it is applied the power feed which has three geared changes and a quick return mechanism. It has also an automatic knockoff which enables the operator to drill a hole of any required depth. The table may be raised or lowered on the column for adjustment by means of the hand wheel shown at the left. The base of the machine is planed so that if it is required to drill work of extreme length, the table can be removed and the work be directly clamped to the base. The table is 18 inches by 24 inches, and the net weight of the machine with countershaft is about 3,600 pounds. The Baush Machine Tool Co., Springfield, Mass., are the builders.

SMALL ELECTRIC BENCH DRILL—ELECTRIC BREAST DRILL.

We show herewith two of a series of small electrically-driven tools recently developed by the General Electric Co., whose main offices are at Schenectady, N. Y. That shown in Fig. 1 is a bench drill particularly designed for the use of jewelers, repair men, and manufacturers who have a large amount of drilling to do of a kind that does not require severe service. The motor and drill spindle are mounted together in

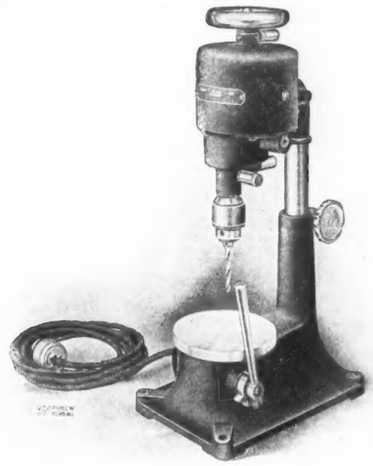


Fig. 1. Small Electrically-driven Bench Drill.

a head which is adjustable for height in the standard at the rear of the base. The motor is of the vertical type and furnished with self-oiling bearings and drives the spindle through a single gear reduction. The handwheel mounted on the armature shaft at the top is convenient for turning the spindle and gives the apparatus a flywheel effect as well, thereby ensuring a smooth and steady rotation of the drill. The motor is series wound and can be supplied with 115 or 230 volt winding for use on direct current circuit only. The

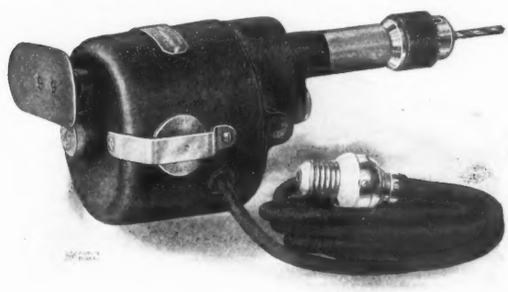


Fig. 2. Electrically-driven Breast Drill.

outfit includes 10 feet of attaching cord and an Edison attaching plug. The largest drill the chuck will hold is 21/64 inch diameter. The work is fed to the drill by raising the circular table, which has a movement of 1¼ inch vertically. The motor has 6 inches vertical adjustment. The whole outfit weighs about 40 pounds and rests on a broad base 6 inches wide by 10 inches long. The outfit is finished in black japan with nickel-plated trimmings.

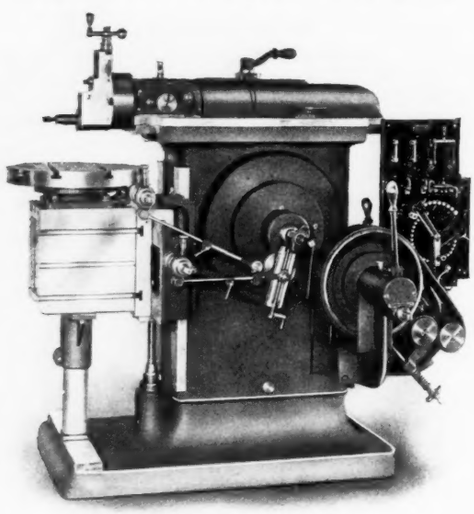
The breast drill, shown in Fig. 2, is similar in capacity and

design of motor to the bench drill just described. The oiling of the bearings is effected through protected oil holes which replace the self-oiling features of the bench drill motor. The self-oiling bearing is not practicable with this drill since it is used in all conceivable positions and oil could not be prevented from escaping from the reservoirs. The tool is provided with a suitable switch on the body of motor so arranged as to bring the drill under the instant control of the operator. The switch is well protected from damage and strongly constructed. With the outfit is furnished chuck and extension cord with Edison attaching plug, permitting a radius of action of 10 feet from the source of the current supply.

Among the other interesting small motor driven tools recently developed by the General Electric Co. might be mentioned a domestic grinding and buffing outfit which consists of either a direct or alternating current motor, as the case may require, of suitable power and speed, and furnished with buffing and grinding wheels. These outfits are useful for grinding knives, scissors and other similar edged tools, and for polishing small silverware, jewelry, etc. They are furnished for 110 volts direct current and 110-volt alternating current, or in special cases, for 220-volt alternating current. The direct-current motor weighs but 15 pounds; with alternating current the outfit weighs about 25 pounds. The tools are adapted for the intermittent service required in the ordinary household but are not suitable for the heavier and continuous work which is required by jewelers, dentists, etc. Other and larger outfits are furnished by the manufacturers for this more exacting service.

CIRCULAR TABLE FOR THE STOCKBRIDGE SHAPER.

The accompanying halftone shows a circular attachment that has recently been applied by the Stockbridge Machine Co., Worcester, Mass., to one of their 16-inch crank shapers. As shown, it consists of a rotary table driven by a worm engaging with a wormwheel formed on the under surface of the table, which may be rotated by a ratchet feed derived from



Stockbridge Shaper with Circular Table.

the same source as the regular cross feed of the table. The feed is so arranged as to permit the operation of the cross feed and the circular feed at the same time, or the use of either one separately. The feed is adjusted by means of a sliding block operated by a screw, and the adjustment can be made while the machine is in operation.

CRESCENT ANGLE BAND SAW.

The Crescent Machine Co., of Leetonia, Ohio, are introducing an angle band saw which presents some novel features. The most noticeable difference between this machine and the standard type is in the way in which the blade is adjusted in relation to the table to saw on an angle. This is ordinarily done by tilting the table up to the required amount, the wheels being fixed in position, the saw itself remaining vertical. In this machine, however, the table is always horizontal. When it is desired to use the angle cutting features, the hand wheel shown at the front of the table is revolved. This tilts the frame carrying the band wheels backward on the lower wheel center as an axis, thus inclining the saw to the table to any extent desired. At the same time that this is

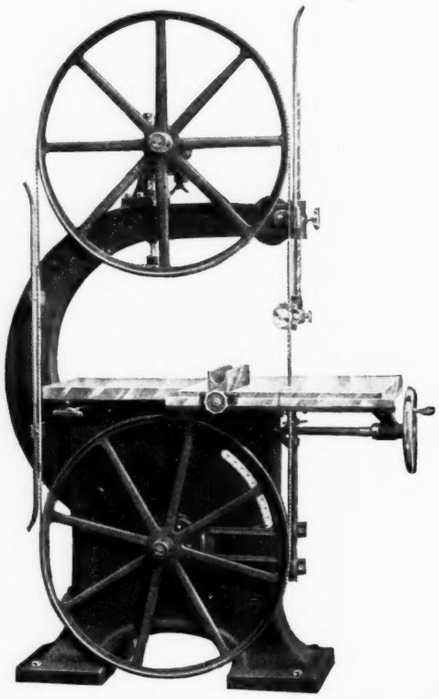


Fig. 1. Crescent Angle Band Saw in Vertical Position.

done the table is moved backward the proper amount to keep the saw in register with the saw slot. This travel of the table is taken care of automatically, so there are no sliding throat blocks to push into position. If desired the machine may be tilted while the saw is cutting. This feature is useful for boat work and other work of a similar character. The guides keep the proper alignment without attention. The

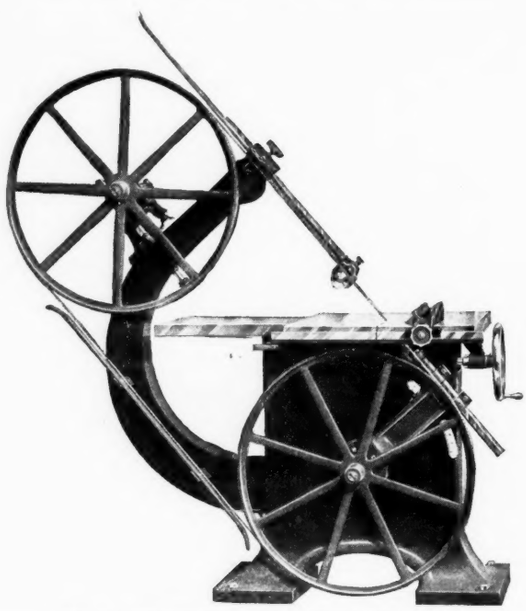


Fig. 2. Crescent Angle Band Saw in Tilted Position.

arm is suitably counterbalanced so that the handwheel turns easily. Extreme simplicity is also claimed for the machine, there being but a few more parts used than on the common type of bandsaw made by the same manufacturers. The novel features of the machine are covered by patents recently issued.

THE "SIM-PULL" COUNTERSHAFT.

In the half-tone, Fig. 1, and the line cut, Fig. 2, are shown the design and construction of a countershaft with an interesting belt shifter, manufactured by the Mossberg Wrench Co., Central Falls, R. I. In the construction shown in the half-tone the device is self-contained in one hanger and comprises a tight and loose pulley shaft, and a driving pulley for the machine, together with the mechanism by which the belt is shifted. This latter is shown more clearly in Fig. 2. The machine is started and stopped by pulling a cord attached to the pendulum slide *G* which is normally held in the position

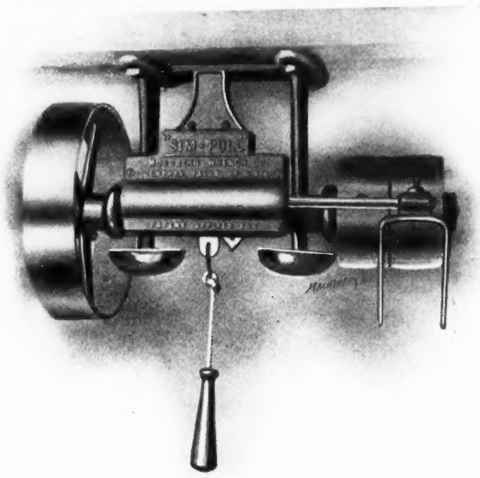


Fig. 1. "Sim-Pull" Countershaft.

indicated by a spring not shown in the cut. Projection *F* on this pendulum slide furnishes an abutment for the shipper slide at *D* and prevents the same from moving. When the cord is pulled, however, drawing *G* downward in a vertical direction, projection *F* is withdrawn so that the shipper slide is no longer locked in position. A continued downward movement of *G* lowers the pendulum *A* which engages with cam *B*, and by it is swung to one side, engaging and shifting the shipper slide *C*, and with it the belt. At the end of this movement slide *C* strikes cam *B* and moves it as shown by the dotted lines so that the next time the cord is pulled pendulum *A* will be swung in the opposite direction, returning the shipper and its slide to the position shown in the cut. If, by carelessness on the part of the operator, the slide *G* is not pulled down to its full extent, in its return projection *F* engages with either of the inclines *H* or *I* as the case may be and wedges the shipper slide to one extremity of its throw or the other. This provision makes it impossible for the shipper to stop half way between the off and on position. In either position it is of course effectively locked by the

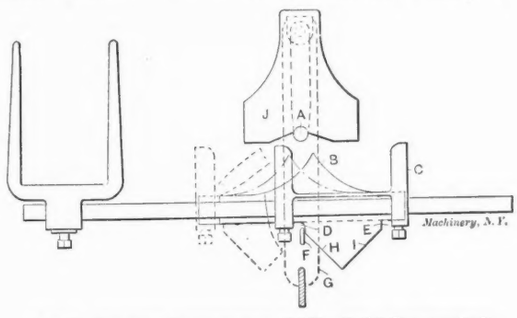


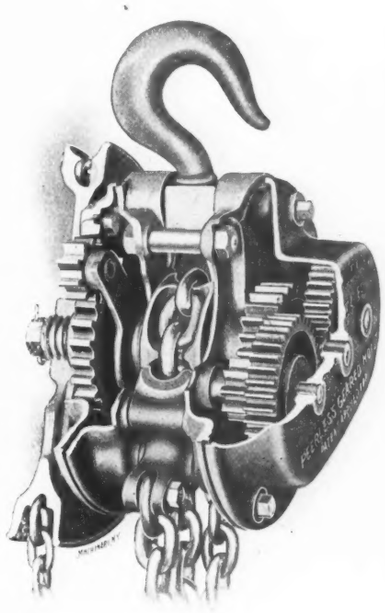
Fig. 2. Showing Construction of "Sim-Pull" Countershaft.

projection *F* engaging with slide *D* or *E* of the projection on the shipper slide. At each return of the pendulum it is guided to and located in its proper starting position by the form on the bottom edge of plate *J*. This countershaft is made in six sizes, for tight and loose pulleys ranging from 4 inches in diameter by 1¾ inch wide to 9 inches in diameter by 4¼ inches wide, the smaller sizes being supported by one hanger with the pulleys supported between them if so desired. The loose pulley on these countershafts is bushed with an Arguto oilless bearing, thus requiring no oiling.

PEERLESS HOIST.

The "Peerless" is a recently designed hoist of the spur gear type, embodying a number of new devices. The good qualities obtained in the design are safety, durability, speed and power. The internal mechanism is quite plainly shown in the cut, which is reproduced from a photograph of a hoist which has been cut open to show the mechanism. The main train of gearing consists of a double set of compound balanced steel spur gears, machine cut from drop forge blanks. These operate the hoisting chain drum which is concentric with the hand wheel shaft but revolves in separate bearings in the frame. The gearing arrangement insures an equalized bearing on the surface of the teeth, reduces wear to a minimum, and gives a free and smooth action to the hoist.

The function of sustaining the load is performed by two friction disks with a leather washer between them mounted on the hand wheel shaft next to the wheel. The hand wheel is screwed upon the threaded hub on one disk, and in hoisting clamps both disks tightly together. The threaded disk is keyed to the shaft. The other disk has teeth cut upon its outer periphery as shown and is loosely mounted upon the hub of the first one. The teeth in this disk engage those of a small pinion which is mounted on a freely rocking arm which encircles the hand wheel shaft and is pivoted below it. The teeth of this gear and pinion are of such a form that they revolve noiselessly and freely in the direction which is taken by the hand wheel when the load is raised. When the raising ceases the load tends to revolve these gears in the opposite direction but owing to the peculiar shape of the teeth, the small pinion is unable to revolve and consequently the rocking arm is thrown backward until a steel dog formed in the cover plate engages with the pinion and thus effectually locks the hoisting device and prevents the load from descending of its own weight. When, however, the operator desires to lower the load, a pull of the chain in the other direction unscrews the handwheel for a portion of a revolution on the threaded hub of the friction disk on which it is mounted. This disengages the frictions and allows the hand wheel shaft to rotate within the toothed friction disk, thus permitting the load to descend. Whenever the backward motion of the handwheel ceases, the disks automatically tighten by being screwed together by the moving load, which is thus stopped. Any possible danger of the load chains slipping is eliminated by an improved arrangement of chain guard and stripper. A flaring hand wheel guard is provided which permits the operator to stand at one side without having the chain drag in the guard. It is built by Edwin Harrington, Son & Co., Inc., 17th and Callowhill Sts., Philadelphia, Pa.



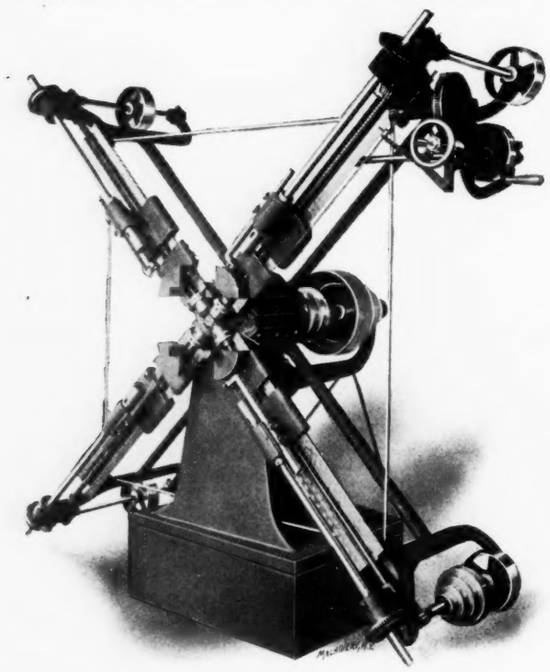
Peerless Hoist.

FOUR-SPINDLE DRILL.

The cut herewith is of a four-spindle drill designed to drill flanges or tubing. All four spindles are arranged to drill to the center and each drill head is gibbed to a radial arm and can be adjusted in or out to permit holes to be drilled in a circle ranging from 3 to 40 inches in diameter. The pipe or flange to be drilled is held by an internal chuck consisting of

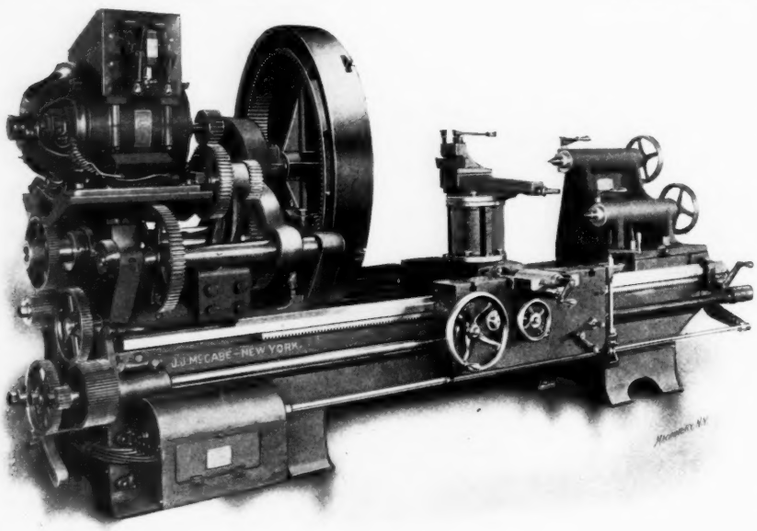
four sliding heads which also move in or out on the radial arms, as clearly indicated in the engraving.

The drilling heads have automatic screw feeds and separate adjustment to allow for drills of different lengths. The feeds for the four spindles are obtained from a four-step cone pulley which supports a worm and worm gear and through which power is transmitted to one of the feed screws. This



Four-spindle Drill.

screw has a pinion at its inner end, near the center of the machine, which drives similar pinions on the inner ends of the three feed screws, by this means transmitting the feed motion for the other three heads to these several gears. There is also provision for feeding the spindles by hand, a crank for this purpose being plainly shown on the right-hand upper radial arm in the engraving.



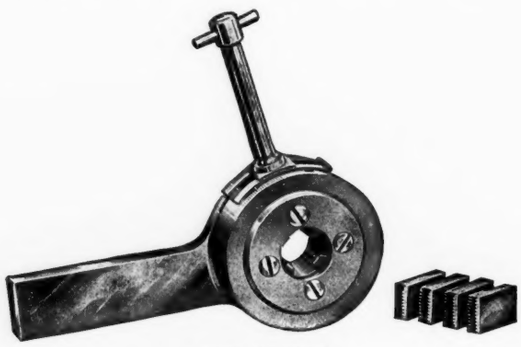
Motor Equipment for McCabe Lathe.

The machine itself is driven by a three-step cone pulley on the countershaft at the rear of the machine; and on this shaft are the four pulleys from which radiate the belts to the four pulleys on the extreme ends of the radial arms, and from which the several spindles are driven.

With each spindle is an adjustable drill gage to properly center the hole. The feed also has an adjustable automatic stop to enable holes to be drilled to any given depth. This machine is built by the Hoefer Mfg. Co., Freeport, Ill.

LATHE DIE STOCK.

The Standard Machinery Co., Bowling Green, Ohio, have designed a lathe die stock for cutting accurate threads on pieces held between the lathe centers. It is clamped in the tool post of the lathe and may be used in connection with the lead screw if desired, the thread being cut at one operation. By the use of the lathe chuck rough bolts can be threaded the



Lathe Die Stock.

same as in a bolt cutter. The tool is made in two sizes, the smaller of which will cut threads from ⅛ inch to 1 inch in diameter and the larger of which will cut up to 1½ inch in diameter. There are four dies to a set and the change from one size to another can be made quickly. Threads under and over size can be cut by means of an attachment which provides a simple means for adjusting the die.

MOTOR EQUIPMENT FOR McCABE LATHE.

A standard mounting for motor equipment for the McCabe double-spindle lathe has been adopted by the builder, J. J. McCabe, 14 Dey St., New York. The motor sets on a table supported by brackets above the head stock and the lathe is driven through a train of reducing gears, which transmit motion to the large cone gear of the lower lathe spindle. The equipment illustrated consists of a seven horsepower variable-speed direct-current motor which runs at 350 revolutions per minute at its lowest speed and has a range up to 1,750 revolutions per minute through twenty steps in the controller. While nominally of seven horsepower, the motor is capable of heavy overloads and can be operated for two hours at 25 per cent overload without overheating. The controller is a full reverse drum type placed on the floor at the front of the head stock with its spindle geared to a splined shaft extending along the bed and operated by a crank with an index pointer and dial on the lathe carriage. The circuit breaker is mounted on a slate slab conveniently placed in front of and above the motor. The purchasers of the lathe may supply their own motor, if desired, as the lathe can be furnished with the table and brackets and the necessary gearing for connecting with any type of motor, including the alternating-current type.

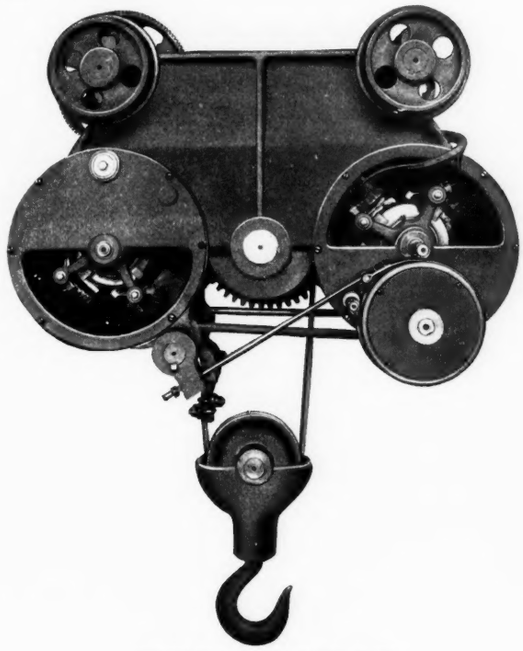
STEEL FRAME HOIST.

The illustration is of a newly designed hoist which is built in sizes 3, 5, 6 and 10 tons capacity by the Detroit Engineering Works, Detroit, Mich. The frame is of steel, cast in one piece, including the frames for the hoisting and propelling motors. Cast integral with this frame are also the boxes supporting the truck wheels. On the side of the hoist where the gears are placed, and where all the strains come, the web plate is cast as part of the frame and is of steel. This is on the side opposite to the motors. The plate on the side where the motors are located is cast separate and is removable, giving complete access to all parts of the motors. The pinions and their shaft are in one piece and the gears and pinions are all interchangeable.

The cast-iron drum is turned and grooved for plough-steel

cables and is supported at each end so that it cannot be pulled out of alignment, since there is no overhang pull on the drum.

The armatures of the hoisting and propelling motors are of the same size and are interchangeable, except in the 10-ton hoist. They are mounted on independent spiders, which also carry commutators and can be easily removed from their shafts.



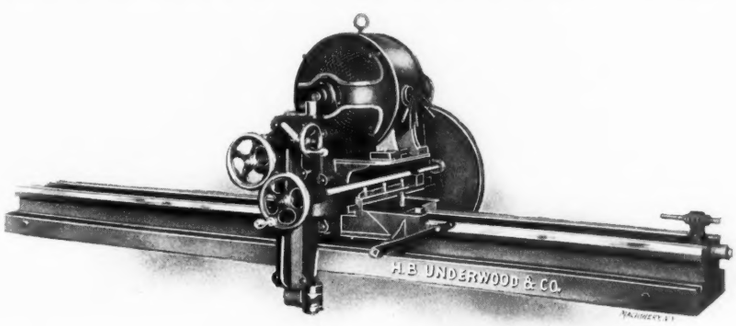
Detroit Engineering Works Hoist.

A simple type of automatic brake is employed, every part of which is accessible, and there are no solenoids or other electrical devices used in connection with the brake. Provision is made against dropping a load through carelessness, since it can be lowered only by rotating the motor.

Another feature of construction is the use of oilless bearings, which were adopted to avoid cutting out bearings through neglect to properly oil them. There are grease cups on the truck wheel bearings, but all others are run without the use of oil or grease. The controllers are of the rotary reversible type and can be mounted on the frame of the hoist or in a cab on the frame of the crane and be operated either by a pendent or an ordinary controller. These hoists are well adapted to be mounted on either single or double I-beams, which in many cases is a satisfactory arrangement and less expensive than the regular type of crane.

SPECIAL PORTABLE MILLING MACHINE.

This portable milling machine is an evolution from a temporary rig which was employed on special work by its builders, H. B. Underwood & Co., 1025 Hamilton St., Philadelphia,

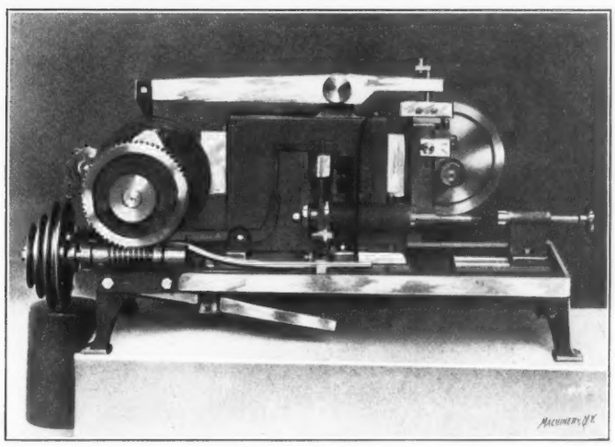


Underwood Portable Milling Machine.

Pa. The original idea has been elaborated on from time to time until it has become one of their regular line of special tools. It is designed for straight line work up to 8 feet in length, for milling a number of surfaces which are in line but on different planes. The machine is mounted on a sub-base allowing accurate adjustment by means of set screws which bear against taper spacing pieces, thus holding the two beds as securely as though they were in one piece. The sub-base has slots and projections for securing it to the work by clamps or bolts. On the base is mounted a carriage with its attached driving motor. The carriage has a travel of 8 feet with automatic feed, while the cross slide has a hand feed travel of 12 inches. The vertical spindle has an up and down adjustment of 10 inches and is bored to receive taper shank mills. The fact that the machine is motor driven allows it to be readily carried about to any place where work is required to be done. It will do work of a character impossible for regular machine tools to handle, and is particularly adapted to taking long cuts on partially or fully assembled machines.

AUTOMATIC MACHINE FOR CUTTING SMALL GEARS.

The Vandyck-Churchil! Co., 8 Dey St., New York, is putting on the market a new small automatic gear-cutting machine built by the Standard Mfg. Co., Bridgeport, Conn. This machine is adapted to making small bevel gears, pinions, spur



Small Automatic Gear Cutter.

gears, etc., up to 4 inches in diameter, and by furnishing special cams can be used to cut irregular outlines. It will cut teeth in single blanks, or in stacks up to 2 inches long. The various motions of feeding the cutter, raising it out of the work, indexing the blank, returning the cutter to commence the next cut, and dropping it into its position, are all attended to by cams on a constantly running cam shaft which is driven by a worm and worm wheel from a three-speed pulley. This, in combination with other changes in the mechanism gives a series of nine different feeds. Two speeds are provided for the cutter spindle. The cutter works ninety per cent of the time, as it is raised clear of the work while returning, and the indexing, which is positive, is performed at this time. Both the work and cutter spindles have taper bearings with compensation for wear. Owing to the simplicity of its construction there is little chance for the machine to get out of order and it can be run at the highest desirable speed without noise or vibration.

MACHINE FOR MAKING PAPER TRANSPARENT.

A novel machine has been brought out by Chas. L. Crabb & Co., 21 Lincoln Place, Brooklyn, N. Y., which, in connection with what is really a new process, is intended to do away with the tracing and inking-in of original drawings in drafting-rooms and engineering departments of manufacturing plants and offices. The principle of the machine and process is to render drawings which have been made on white paper with lead pencil or ink permanently transparent so that blueprints may be taken from them. Paper thus treated is so

transparent that prints can be made from it in less time than from tracings, and it is entirely unnecessary to ink in a drawing, since pencil lines give sufficient contrast to make a clear print.

Fig. 1 is reproduced from a pencil drawing which was cut in two, one-half treated by this process, while the other half remained in its original state. The two pieces were placed side by side over a page of MACHINERY, and it will be noted from the engraving that the left-hand half, which is the treated portion, is so transparent that the printing underneath is easily read, while the right-hand part is entirely opaque.

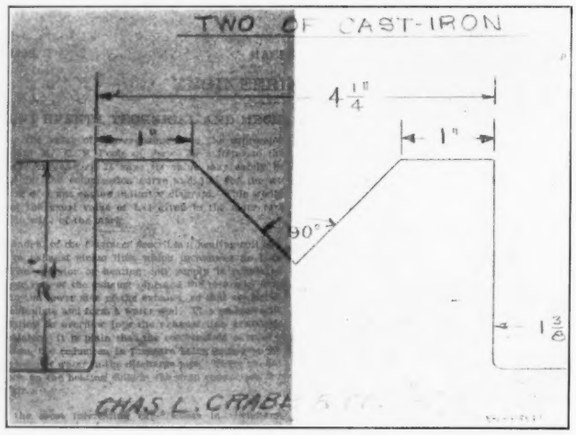


Fig. 1. The Left Half of Drawing has been made Transparent and the Characters of a Printed Page underneath are Plainly Visible.

The left-hand part appears darker than the other in the engraving, because after being treated the paper is slightly yellow, a color which reflects but few actinic rays and produces a dark photographic print. When photographs are to be treated, a tray, which forms a part of the machine and contains the solution to be used, is heated either by a Bunsen burner or an electrical resistance coil, as most convenient; and the sheet is fed into the machine and passed through this heated bath by the rotation of a crank. After leaving the bath the sheet passes between hot calender rolls which squeeze out the surplus liquid, giving the sheet a smooth and dry surface. The process requires less than a minute.

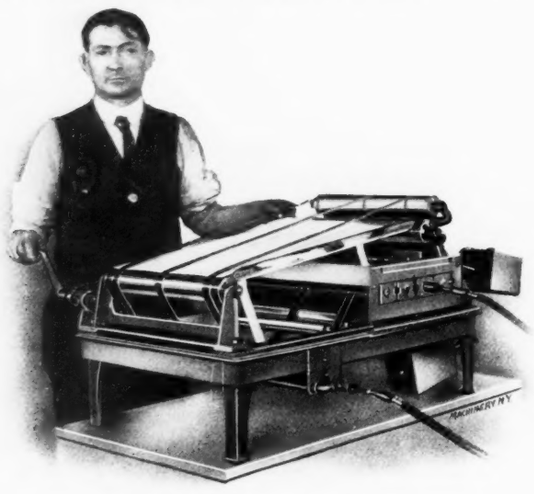


Fig. 2. The "Transparentizer" in Use.

Drawings subjected to this treatment are not only transparent, but water and mildew proof, and the solution used is of such a character that the paper is not greasy or oily and will not stain blueprint paper during the process of printing, even when the printing is done in warm weather and by sunlight. An important question that might be raised in regard to this process is whether drawings can be easily corrected after the paper has been treated. We are informed that this is possible by first erasing the pencil lines and using a solution such as naphtha, to cut the coating given to the paper and restore the original surface of the paper. Pencil marks can be made upon it, after which the whole sheet is run through the machine again and the place where the correction was made is restored to its former transparent condition.

Illustrations 2 and 3 give an idea of the relative size of the machine. Drawings are carried through the bath and between the calender rolls by means of endless metal belts. It is said by the manufacturers that it is possible to "transparentize"

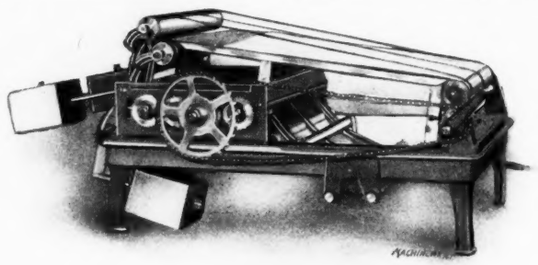


Fig. 3. Opposite Side of "Transparentizer."

drawings which have been made on heavy Bristol board. It is believed that the process will almost entirely do away with the making of tracings in offices where the machine is adopted, thus saving a large item of expense and giving entirely satisfactory blueprints. The machine is styled by the builders a "transparentizer."

TOOL HOLDER FOR LATHE AND PLANER WORK.

The Bown Machine Co., Ltd., of Battle Creek, Mich., make the improved lathe and planer tool holder shown in the accompanying halftone. As may be seen it takes a larger and longer cutter bar than do most of the holders of the same size, many of which take only a very short piece of tool steel, of which not more than half, perhaps, can be used. With this tool

Tool Holder for Bar Stock.

any desired length can be used. The tool-post screw is set down on the cutter bar, thus holding it very rigidly. The end of the blade may be ground for plain turning or side tool work, or formed to shape for thread cutting, etc. It may be extended forward so as to cut into a narrow space and will take a good-sized cut without chattering, owing to the large size of stock used.

* * *

An error was made in the article "The Machine Shops of the Pratt Institue" appearing in the April issue. In the list of tools mentioned as forming a part of the machine tool equipment it was stated that an Espen-Lucas boring machine was one of the tools, whereas this tool is a Lucas precision boring machine built by the Lucas Machine Tool Co., Cleveland, Ohio.

* * *

PERSONAL.

MR. A. A. SCHAEFER, formerly associated with the Standard Engineering Co., Ellwood City, Pa., in the capacity of general sales agent for New York City and surrounding territory, has severed his connection with that company, and is now connected with the Stoever Foundry & Mfg. Co., making his headquarters at the New York office, 95 Liberty Street.

GORHAM C. PARKER, formerly manager of the Superior Tap Co., Springfield, Vt., and later New England representative of the Pittsburg Tool Steel Wire Co., Monaca, Pa., has resigned the latter position to accept the position of sales-manager for the Jacobs Mfg. Co., Hartford, Conn.

FRESH FROM THE PRESS.

STEAM BOILERS, THEIR HISTORY AND DEVELOPMENT. By H. H. P. Powles, 336 pages, 7½ x 10½ inches, and 15 full-page plates, 181 cuts besides the full-page plates. Published by Archibald Constable & Co., Ltd., London, and J. B. Lippincott Co. ,Philadelphia. Price $6.00.

As indicated by the title the book is a review of steam boilers, giving an account of the earliest known examples and including the modern types. The book is largely in the nature of a compilation and contains much matter that has been previously published, but in this book it is brought together in an attractive way and should be a welcome addition to the library of many mechanical engineers, especially those of the scholarly type. Following are the titles of the chapters: Early Ideas on the Nature, Production, and Uses of Steam; Savery, Newcomen, Beighton; Jonathan Hulls, Payne, Smeaton, Brindley, Cugnot; Watt, Boulton, Symington, Trevithick; Nathan Read, Count Rumford, Trevithick; Trevithick, Woolf, Fulton, Stevens, Linaker, Bell; Blenkinsop, Hedley, Stephenson, Griffiths; James, Jacob Perkins, Joseph Eve, McCurdy; Stephenson, Neville, Goldsworthy Gurney, Sequin; Walter Hancock; Trevithick, Church, Maudslay, Penn, Maceroni and Squire; Plain Cylindrical, Cornish and Lancashire Boilers; Locomotive Boilers; Marine Boilers-Return Tube Boilers; Vertical Boilers; Sectional and Combination Boilers; Fire Engine Boilers; Water-Tube Boilers; Motor Car Boilers; The Development of Steam Boilers.

STEAM TURBINES. By Carl C. Thomas, Professor of Steam Engineering, Sibley College, Cornell University. Published by John Wiley & Sons, New York, 287 8vo. pages, illustrated. Price $3.50.

This bears the distinction of being the first American work on the steam turbine. It is primarily a text book on the design of turbines and is intended for the instruction of college students. It is a less comprehensive work than Stodola's treatise, but it appears to us to be better adapted to the use of students than the latter, since it outlines the principles of design and the results of experimental investigations more fully and clearly than the work by the German author. Prof. Thomas points out that the development of the turbine has been so rapid that many of the problems involved, while solved satisfactorily for constructive purposes have not been put upon a scientific basis. He has attempted to supply this deficiency in a measure by analyzing the results of many tests upon the flow of a steam and correlating them in a way to make them applicable to problems that arise in the design of this type of motor.

The book opens with a chapter discussing the action of steam jets upon vanes, followed by a short discussion of the principles of thermodynamics, in which special attention is devoted to the subject of the flow of steam. Perhaps the most important chapter in the book is one dealing with experimental work on the flow of steam through nozzles and against turbine buckets. The work of most of the leading experimenters in these lines has been reviewed and some new results obtained during the past year or two at Cornell University are here published for the first time. In subsequent chapters, dealing more directly with the design of the turbine, calculations are carried through in which co-efficients for frictional losses are introduced, derived from the tests given in the previous chapter.

The book closes with chapters containing tests upon turbines and illustrations of several types of turbines and their details, and a brief review of the main facts as far as available concerning the marine turbine.

Certain subjects covered by Stodola's book are not touched upon in the one under review, one of these being the centrifugal and radial stresses in rotating bodies. There are several valuable charts in the book to facilitate calculations and altogether we think Prof. Thomas has done a valuable work in preparing this treatise, since many colleges, as well as engineers, have been looking for matter bearing upon this much discussed motor.

NEW TRADE LITERATURE.

GISHOLT MACHINE CO., Madison, Wis. Leaflet describing and illustrating Gisholt 30-inch mill, and power moving device for the rapid traversing of turret slide on Gisholt lathes.

THE STANDARD MACHINERY CO., Bowling Green, Ohio. Catalogue of Standard Bolt Cutters. On the front of each page is shown a half-tone view of a type of Bolt Cutter and the back gives description and specifications of same.

THE E. G. SMITH CO., Columbia, Pa., have issued a circular offering a new clubbing proposition and describing a few special machines, among which might be mentioned the patternmaker's caliper. This circular will be mailed to all interested.

THE GARVIN MACHINE CO., Spring and Varick Streets, New York City. 1906 Catalogue, completely illustrating and describing various types of milling machines, profiling machines, screw machines, forming machines, lathes and other Garvin products.

NORTHERN ELECTRICAL MFG. CO., Madison, Wis. Bulletin No. 48, devoted to grinders of various sizes as well as buffing lathes. Work with a complete grinding department or individual grinders may be done with economy and expedition by the use of Northern grinding equipments.

LUCAS MACHINE TOOL CO., Cleveland, Ohio. Pamphlet entitled "All Men are Liars," wherein is shown that some men are not. The above-named company will look over your work and will give their *honest* opinion as to whether or not their tools would be best suited for your purposes.

NEWTON MACHINE TOOL WORKS, Philadelphia, Pa. Catalogue No. 43, illustrating cold saw cutting-off machines. These tools, which have been recently redesigned, range from the small bar saw, with a capacity of 2 inches up to a large machine for engine cranks and forged stock, having a capacity of 21 inches.

THE ONEIDA NATIONAL CHUCK CO., Oneida, N. Y. Catalogue of Chucks. The book is divided into two parts, the first part being devoted to Lathe Chucks and the second part taking up Drill Chucks. Illustrations and specifications are given. The company will make special chucks upon receipt of sketch showing the type desired.

THE Ingersoll-Rand Co., 11 Broadway, New York. Catalogue No. R. 37, treating of air and gas compressors. This is well illustrated with cuts made from photographs of machines designed and built by the company. Specifications and descriptions of many of the types are given. A brief description of the Batcheller Pneumatic Tube system and its application at various post-office stations is included.

GOLDSCHMIDT THERMIT CO., 43 Exchange Place, New York. Booklet discussing the uses of Thermit. Thermit is a mixture, in powder form, of iron oxide and finely divided aluminum, which is absolutely non-explosive. It may be used by electric railway companies in welding rails, by railroad shops in repair work, to weld pipes, rods and bars, and in various other ways. Those interested in the process should obtain a copy of the booklet.

THE *Monthly Progress Reporter* issued by the Niles-Bement-Pond Co., 111 Broadway, New York, is one of the most finely executed illustrated pamphlets issued by any machinery firm. In each number the space is given up mainly to large half-tone engravings made from photographs of machinery built by the several firms of this organization and as they appear when installed in different machine shops. The issue of April contains 29 full-page illustrations from the Bethlehem Steel Co., South Bethlehem, Pa., showing the massive machinery placed by the Niles-Bement-Pond Co. in these shops.

THE HEALD MACHINE CO., Worcester, Mass. Illustrated catalogue of the Heald cylinder grinder and Heald ring and surface grinder. This is an attractively prepared catalogue and shows the several types of grinders that this firm have developed, especially for automobile work, though they are adapted to other lines of manufacture as well. The ring and surface grinder has a rotary instead of a reciprocating motion. The cylinder grinder is of the type in which the axis of the wheel spindle revolves through the circumference of a circle and the cylinder remains stationary instead of rotating.

THE SKINNER CHUCK CO., New Britain, Conn., have published a Loose-Leaf Price List, made to fit No. 6 Morden's Loose-Leaf Price Book, which has been adopted by the National Supply and Machinery Dealers' Association. These books are put together with a silk cord and are perforated to slip in place in the Loose-Leaf Price Book of standard size. They consist of tables and information in regard to their line of chucks, with single illustration of the different styles of chucks on the back of the page. It is possible to use any one leaf or the entire series, as desired. Copies of this price list are now being distributed.

THE BULLARD MACHINE TOOL CO., Bridgeport, Conn. Illustrated catalogue of boring mills and turret lathes. This catalogue, in the excellence of its engravings and topography, is one of the handsomest that has recently been issued. It has numerous half-tones, executed in an unusually attractive style, and describes the full line of boring mills made by this company, ranging in size from the 30-inch turret machine to a 120-inch mill of the regular type. The 36-inch rapid-production vertical turret lathe and three types of horizontal turret lathes are also listed. The machines are shown both with and without electric drive and there are illustrations of various types of small tools recommended for their different machines.

MANUFACTURERS' NOTES.

THE NILES-BEMENT-POND CO. have removed their Pittsburg offices to 713-714 Frick Building, Pittsburg, Pa.

EBERHARDT BROTHERS MACHINE CO., Newark, N. J., have just completed an addition to their factory, to be used for erecting purposes.

THE NATIONAL MACHINE TOOL CO., Cincinnati, Ohio, build a ½-H. P. type of improved speed changer which will vary the speed of the work drum of all belt-driven No. 2 Cincinnati Milling Machine Co.'s grinders.

THE DERRY COLLARD CO., New York City, will remove their offices from 256 Broadway to 109 Liberty Street, New York City. Their business has increased so rapidly that twice during the past three years have they been obliged to seek larger quarters.

L. H. Gilmer & Co., 504 Arch St., Philadelphia, Pa., are putting in a stock of polishing machinery and polishing supplies which they will handle in connection with their endless polishing belts known as The Gilmer Endless Belts. A catalogue of these supplies is now ready for distribution.

BERTSCH & CO., Cambridge City, Ind., have recently turned out the largest shears they have yet built. They are for Worth Bros. Co., Coatesville, Pa., and weigh 50 tons. They have two 10½-foot blades for cutting 1-inch iron 10 feet wide at one stroke. The shears are hydraulically driven.

THE S. OBERMAYER CO., Cincinnati, Ohio, preparatory to remodeling its Cincinnati offices, has taken temporary quarters in the Union Trust Company Building. Extensive improvements will be made, as the company has felt for some time that the capacity of its general offices was inadequate to meet its rapidly growing business.

THE WELLMAN-SEAVER-MORGAN CO., Cleveland, Ohio, at their recent annual meeting, elected S. H. Pitkin to the office of general manager, which place has been vacant since the death of Chas. H. Wellman last June. Mr. Pitkin will also serve as first vice-president of the company. No other changes were made in the officers of the company.

THE HISEY-WOLF MACHINE CO., Cincinnati, Ohio, have been advised by Alfred H. Schutte, their Brussels agent, that they have been awarded "Mention Honorable" and given a diploma for their portable electrical hand drills and tool-post grinders, exhibited at the Liege Universal and International Exposition, where competing machines were entered from all over the world.

THE FALLS RIVET & MACHINE CO., Cuyahoga Falls, Ohio, state that the fire which partially destroyed their plant on April 2 was confined entirely to the Rivet and Bolt Department. This is a separate plant, being situated a half mile from their Power Transmission Department, which was not affected in any way by the fire. The company are, therefore, in a position to fill orders from the Power Transmission Department without delay.

THE LUMEN BEARING CO., Buffalo, N. Y., have recently completed a large addition to their plant, owing to the steady increase of their business. The addition is a brick structure and will contain offices, machine shop, shipping department, storage and metal vaults and a molding room 60 x 200 feet, equipped with Coburn track and crane. The principal products of this company are Lumen bronze, brass and bronze castings and aluminum automobile castings.

THE COLBURN MACHINE TOOL CO., Franklin, Pa., who are specialists in the building of boring mills, report a satisfactory trade in Great Britain and Germany. They are represented in Europe by the Ludw. Loewe Co., the well-known German machine tool builders. Their Paris representatives, Destombes, Langlois & Co., have recently undertaken the sale of the Colburn boring mills in France. The builders will be pleased to send special pamphlets covering vertical boring and turning mills from 30 inches to 72 inches swing to anyone who may be interested.

THE Toledo Machine and Tool Co., Toledo, O., builders of bar and sheet metal working machinery, and special tools, who recently moved into their new and commodious factory, have again been compelled by their increasing business to enlarge their plant, and arrangements have been completed for erecting a 200 feet x 100 feet addition in which will be installed the finest grade of machine tools on the market, electric cranes, and all the labor saving devices now known to the trade. A special department will be arranged for in this new building for the manufacture of presses weighing up to 6,000 pounds.

THE CLING-SURFACE COMPANY.

The Cling-Surface Company, of Buffalo, N. Y., have just finished and moved into their fine new plant at 1032-1048 Niagara Street, especially built for the manufacture of their product, and which is of the most modern fireproof construction—brick, concrete, hollow tile and wire glass, for wall, floor and ceiling—providing them largely increased facilities which have been badly needed for a long time.

The writer is familiar with the Cling-Surface business since it was started in a very modest way by Mr. Albert B. Young, whose resources at that time were limited to his experience as a chemist, his reputation for square dealing, and unlimited faith in his invention. There can be no better evidence of the value of any product than that its sales should steadily increase as those of Cling-Surface have done, against prejudice, opposition, and all kinds of competition, till from a limited local demand Cling-Surface is now used wherever belts are driven for the transmission of power.

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THE Technical Publicity Association held its second annual meeting and banquet Thursday, April 5th, at the Aldine Association, New York; Mr. P. F. Kobbé, the former president of the Association, gave an address on the general subject of advertising, and this was followed by an informal discussion in which members and guests took part. The following resolution was passed:

"*Resolved*, That the Association shall take active steps to secure definite information regarding the circulation of mediums in which the members of the Association are interested."

Among the officers elected for the ensuing year were: F. H. Gale, of the General Electric Co., president, and Rodman Gilder, of the Crocker-Wheeler Co., secretary.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

A MACHINIST WANTED in every shop to sell my Calipers and Levels. Liberal proposition. Address E. G. SMITH CO., Columbia, Pa.

A MANUFACTURING CONCERN having a varied line of machinery wish to dispose of one of their lines, which consists of stationary gasoline engines. These engines run in sizes of from 2 to 30 H. P., and are adapted for all kinds of work. Business in this line has run $50,000 a year. Patterns, drawings and good will will be sold at a reasonable figure. Parties desiring to add another line to their business, or those desirous of going into the manufacturing business will find this to be an interesting proposition. Address GAS ENGINE, care MACHINERY, 66 West Broadway, New York.

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